THE IMPACT OF TRANSPORT FROM THE SOUTH COAST AIR BASIN ON OZONE LEVELS IN THE SOUTHEAST DESERT AIR BASIN

VOLUME 2 - RESULTS AND DISCUSSION

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by

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SUMMARY

An observational program was carried out during July-August 1981 to investigate the impact of transport from the South Coast Air Basin on ozone levels in the Southeast Desert Air Basin. The study was conducted jointly by the California Institute of Technology, Division of Chemistry and Chemical Engineering and Meteorology Research, Inc. The present volume (Vol. II) covers the detailed results of the program. Vol. I is an Executive Summary. Vols. III and IV are data volumes prepared by the California Institute of Technology and Meteorology Research, Inc., respectively.

A total of eight tracer releases were carried out by the California Institute of Technology using SF_6 as the tracer material. A total of 34 hourly sampler sites were established for the study. Not all sites were utilized for any given test. Numerous syringe samples were taken during automobile traverses and aircraft flights.

A total of five ozone monitoring stations were established for the duration of the program to supplement the existing ozone network. Aircraft flights were made on each test day by MRI to sample air quality and meteorological parameters. Pibal wind observations were usually made at four locations in support of each test. One of the locations also released an Airsonde at intervals during each test to obtain additional information on vertical temperature structure.

Three tracer releases were made from the western part of the Los Angeles basin (Culver City, Carson and Garden Grove) to document transport into the desert from this area. Two releases were made from the eastern part of the basin (Ontario and South Fontana). One release each was made along the Burbank-Newhall-Palmdale exit route and one in Cajon Pass to investigate transport along these paths. A final release was made at Brawley to examine transport from the Imperial Valley northward into the Coachella Valley.

Tracer trajectories from the western part of the Los Angeles basin followed routes through Soledad Canyon, Cajon Pass, San Gorgonio Pass, up the slopes of the San Gabriel and San Bernardino Mts. and into the Elsinore convergence zone, depending on release location and time of day. Trajectories from the eastern part of the basin and from the immediate pass areas followed expected routes into the desert through the pass and up the mountain slopes. Significant tracer concentrations were observed in the desert from all seven releases made in the Los Angeles basin.

Ozone monitoring data were available during the program from Mt. Wilson, Mt. Baldy, Lake Gregory and Fawnskin (Big Bear). Peak hourly ozone values at Mt. Baldy and Lake Gregory during the field program were the same as Fontana (35 pphm). Maximum observed concentration at Mt. Wilson was 29 pphm. The Fawnskin maximum was only 15 pphm. These data and supportting evidence indicate that a major exit route for pollutants from the Los Angeles basin lies along the slopes of the San Gabriel Mts., through Cajon Pass and extending to the western slopes of the San Bernardino Mts. To the east of Lake Gregory, the transport of pollutants into the San Bernardino Mts. decreases sharply. Other major routes also exist through San Gorgonio Pass and Soledad Canyon. Low-level pollutant transport occurs through the passes and affects the desert areas immediately downwind. In all passes, however, there was evidence of a separate, higher ozone layer moving through the pass which was associated with slope flow along the shoulders of the pass. This upper layer was brought to the surface, on occasion, by lee wave action in the Coachella Valley. On the two observational days in the Mojave Desert, the upper layer remained aloft in spite of strong surface heating.

During the summer months a strong flow of air occurs from the San Joaquin Valley into the western portion of the Mojave Desert, continuing eastward toward Barstow. There is a zone of confluence between this flow and the flow through Soledad Canyon which appears to lie near or slightly north of Edwards AFB on a mean basis. Most frequent wind direction streamlines through Edwards and Barstow suggest an influence from the San Joaquin Valley while Palmdale and Lancaster are most frequently under the influence of the Soledad Canyon flow. Highest ozone concentrations at Edwards AFB, however, appear to be associated with flow from Soledad Canyon which brings air into the desert from areas of large emission sources in Los Angeles County. There was no evidence from ozone concentration, tracer data or wind flow patterns of a Soledad Canyon influence as far north as China Lake.

Carry-over of pollutants in the desert was observed in the form of deep layers of ozone in early morning sampling flights. These layers resulted from transport from the Los Angeles basin during the previous afternoon and evening. On two mornings, peak observed concentrations aloft were 10 pphm or more (Lucerne Valley and Palm Springs). A comparison was made at Palm Springs and Indio of those cases which showed clear evidence of late evening transport from the Los Angeles basin and those where the significance of the transport was much less or non-existent. During the following forenoon the data suggest that the principal effect of the transport was to raise the overall ozone background in the area. The magnitude of the diurnal increase in ozone concentration (from morning minimum to midday maximum) did not apear to be related to the transport of pollutants during the previous evening.

Recommendations include further studies on the effect of slope transport from the Los Angeles basin and the influence of the San Joaquin Valley flow on the Mojave Desert. The importance of the eastern San Gabriel Valley as an early morning reservoir of basin pollutant should also be explored.

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1. INTRODUCTION

The Southeast Desert Air Basin (SEDAB) comprises about 33,000 square miles in southeastern California. The western boundary includes the San Jacinto, San Bernardino and San Gabriel Mountains while the eastern boundary generally follows the Colorado River. The area is sparsely populated with an estimated population of about 500,000 as of January 1977 (ARB Staff, 1978). Industrial source emissions are limited and localized. The largest urban center is represented by Palm Springs and the Imperial/Coachella Valley includes much of the population of the basin.

In spite of the sparse population of the basin violations of the state ozone standard are observed on a number of occasions during the summer months. Results from several studies have indicated that transport of ozone and/or precursors from the South Coast Air Basin (SCAB) may be responsible for the occurrence of these ozone episodes.

An extensive field study was carried out in July-August 1981 to determine, in more quantitative form, the impact of transport from the South Coast Air Basin on ozone levels in the desert. Specific objectives were taken to be:

1. To document the transport of oxidants and precursors from the SCAB into the SEDAB.

2. To delineate the typical downwind extent of and area of influence of the transport through the various passes.

3. To investigate the relative contribution of local sources and previous day's precursors to the morning oxidant increase in the SEDAB.

In order to carry out the field study a cooperative measurement program was conducted involving the following organizations:

Meteorology Research, Inc. (MRI) - Air quality and meteorological measurements including airborne sampling

California Institute of Technology - Eight extensive tracer tests from various locations in the SCAB and the SEDAB

EPA Environmental Monitoring Systems Laboratory - Airborne downward looking lidar measurements

Jet Propulsion Laboratory - Airborne ozone measurements

California Air Resources Board - Supplementary ozone monitoring stations

Edwards Air Force Base - Supplementary radiosonde observations

The South Coast Air Quality Management District, the San Bernardino County Air Pollution Control District and the Southern California Edison Company provided monitoring data from their own networks.

The final report on the results of the study are contained in a number of volumes. The work carried out by MRI and CalTech is described in four volumes:

Volume 1 - Executive Summary
Volume 2 - Extended Summary and Analyses
Volume 3 - Tracer Data
Volume 4 - Meteorological and Air Quality Data

Portions of the study conducted by EPA and JPL are described in McElroy et al. (1982) and Grant (1982), respectively. A supplementary study to incorporate the results of the remote sensing data (lidar and ozone measurements) with the analyses in the present volume is being carried out by Smith and Edinger and will be completed by late 1983.

The above studies, taken collectively, provide strong indications of pollutant transport from the South Coast Air Basin and from the San Joaquin Valley into the Southeast Desert Air Basin. The effects of upslope flow and evidence of layers aloft and transport through the passes were presented. Trajectories through the desert and the influence of local sources on desert pollutant concentrations, however, have not been addressed in any substantial form. The present study was intended to document the transport into the desert in greater detail as well as to consider these additional topics.

2.2 Topography

The Southeast Desert Air Basin is comprised of the area directly to the east and north of the mountain ranges which form the eastern boundary of the South Coast Air Basin. The SEDAB includes all of the desert areas from the mountains eastward to the Arizona and Nevada borders and northward to the northern boundaries of Kern and San Bernardino Counties. A map outlining the SEDAB is shown in Figure 2.2.1.

There are four principal routes through the mountains which border the SEDAB through which pollutants might be transported. These are listed in the following table together with approximate minimum elevations:

Table 2.2.1

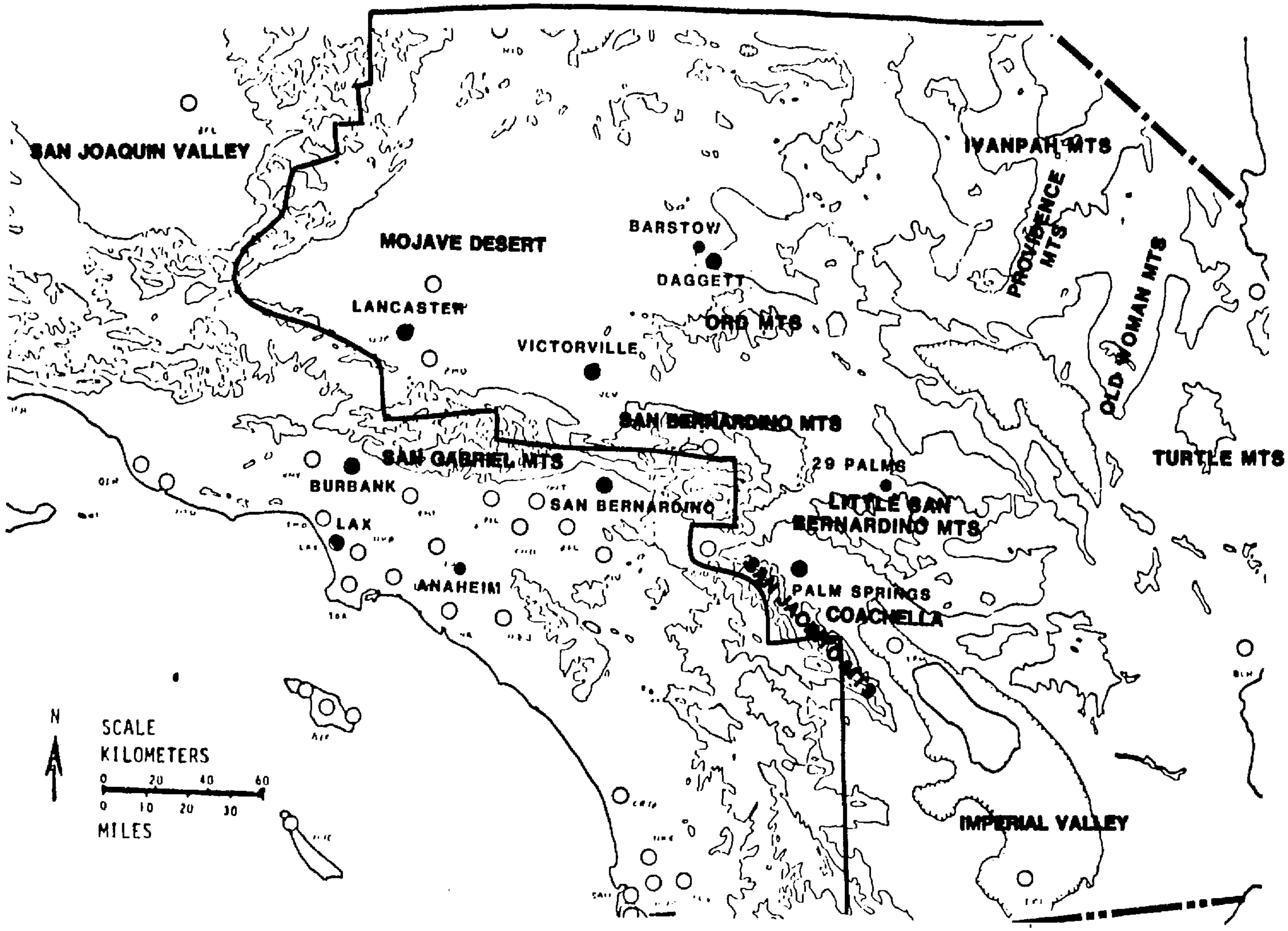
TRANSPORT ROUTES INTO THE SEDAB

Route	Approximate Elevation (Ft [msl])
Tehachapi Pass	3800
Soledad Canyon	3300
Cajon Pass	4200
San Gorgonio Pass	2300

There are several additional routes of a secondary nature from San Diego County into the southern Imperial Valley. One of these potential routes is through Julian with a minimum elevation of about 3500 ft.

Within the SEDAB itself, the primary terrain features which might influence wind flow patterns are shown in Figure 2.2.1. These include primarily the Little San Bernardino Mountains between Palm Springs and 29 Palms, the Ord Mountains south of Barstow and the Clark-Ivanpah-Providence Mountains complex which lies east-northeast of Barstow, almost to the Nevada border.

A map showing locations in the SEDAB and the Los Angeles basin which are frequently referred to in the text is shown in Figure 2.2.2.



MAP OF SOUTHEAST DESERT AIR BASIN

Fig. 2.2.1

2. METEOROLOGICAL AND AIR QUALITY ENVIRONMENT

2.1 Background Literature

During the past ten years a number of studies have been carried out which pertain to the air quality environment in the Southeast Desert and, in particular, to the question of pollutant transport from the South Coast Air Basin.

In 1970-71, Kauper (1971) carried out a study of the possible sources of pollution observed in the Coachella Valley. Aircraft measurements and pibal wind data were obtained during four observational field programs. During the summer and fall, high ozone concentrations in the valley were found to be associated with northwest winds transporting pollution from the area of San Gorgonio Pass. In the winter and spring, high ozone values appeared to be associated with winds from a more northerly direction. Subsidence in the lee-wave flow downwind of the pass was characteristically observed during these occurrences. This subsidence seems to limit the vertical depth of the pollution layer in the desert and tends to keep the pollution concentrations from diluting as rapidly as might otherwise be observed. A nocturnal wind jet was observed on occasion during the summer in the Coachella Valley with air moving rapidly from the northwest at a level of about 1000 ft above ground.

Edinger et al. (1972) and Edinger (1973) traced the transport of oxidant eastward in the South Coast Air Basin by means of aircraft and surface measurements. Significant quantities of oxidant were found to be transported up the slopes of the San Gabriel and San Bernardino Mountains and injected into stable layers aloft. The oxidant in these layers was thus protected from destruction from nitrogen oxides and was free to be transported elsewhere with the prevailing winds aloft. Maximum oxidant concentrations were found at levels of 3000-4000 ft along the southern slopes of the mountains.

Trijonis (1973) examined the question of transport of pollution from the South Coast Air Basin into the desert through a comparison of the diurnal ozone patterns at stations in the basin and the desert. Peak ozone concentrations were found to occur later in the day at desert locations compared to the SCAB stations. Differences in time of maximum ozone occurrence were consistent with observed wind trajectories and velocities.

Drivas and Shair (1974) released SF_6 tracer gas at Anaheim between 1200 and 1245 PDT. Sampling downwind subsequently observed gas concentrations at San Bernardino (1630 PDT), at Palm Springs (1700-1800 PDT) and at Cajon Pass (1800 PDT). The timing of the SF_6 concentrations at Palm Springs coincided with the normal time of maximum ozone occurrence, suggesting a trajectory from the SCAB for the early evening ozone maximum in the Coachella Valley.

Blumenthal et al. (1974) analyzed a series of aircraft air quality measurements and documented the transport of ozone into the desert near Hesperia and the mountain areas near Lake Arrowhead. The presence of ozone layers aloft was also described.

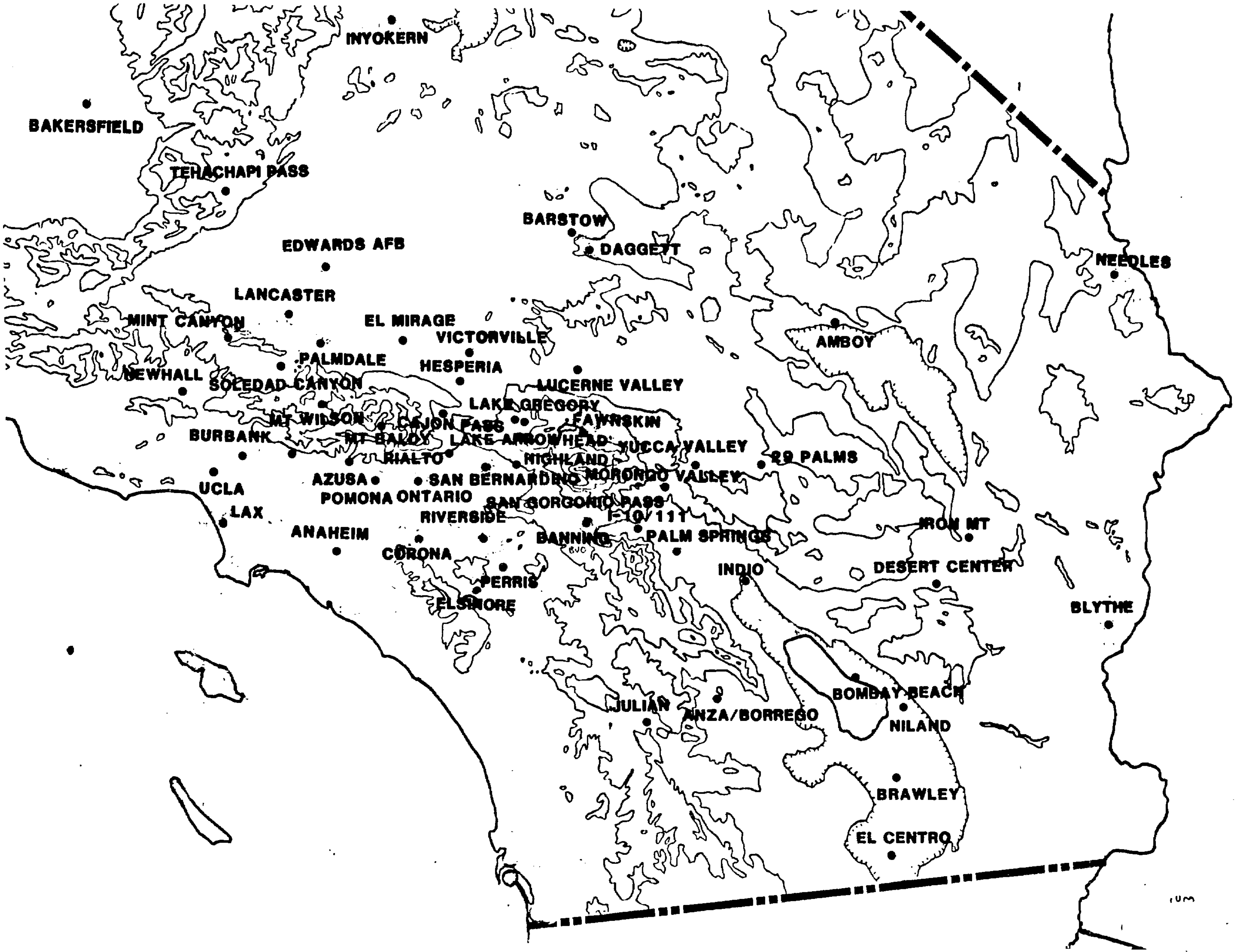
Miller and Lester (1977) performed the first of two field studies for the Bureau of Land Management. Aircraft flights were conducted on six days in the Mojave Desert and in the region from Palm Springs eastward to the Arizona border. Elevated, stable layers of ozone were found over the desert which were attributed to sources in the SCAB.

The second field study for the Bureau of Land Management (Lester and Simon, 1978) concentrated on the flux of pollutants through Cajon and San Gorgonio Passes. Within the limited sampling performed, the flux of ozone through San Gorgonio Pass was found to be substantially larger than that through Cajon Pass. Elevated ozone layers were observed slightly north of Cajon Pass which were apparently associated with flow up the southern slopes of the San Gabriel Mountains. The principal sources of elevated layers were listed as convergence zones, upslope flow and the heating influence of the Puente Hills.

Engineering Science (1980) performed an analysis of existing meteorological and air quality data in the desert area for the purpose of assessing the impact of SCAB-generated pollutants on several potential power plant sites. They examined peak ozone values in the desert and the associated time of maximum occurrence and determined that the observed characteristics were consistent with transport of pollutants from SCAB into the desert. Some evidence of overnight transport into the eastern part of the desert was obtained.

Taylor and Graham (1980) carried out two tracer releases with the support of the Southern California Edison Company. One of the releases was made from Cajon Pass and the other from San Gorgonio Pass under conditions when transport through the passes into the desert was apparent. The tracer released from San Gorgonio Pass split into two segments, one moving into the Morongo Valley (Yucca Valley) and the other into the Coachella Valley. Evidence of tracer material was found at Turtle Mountain (southwest of Needles) at 13 and 18 hours after release. The trajectory of the material released in Cajon Pass was not as well documented but probably moved northeastward through the Barstow area. Residual amounts of tracer material were noted for several days after the release but their sources and trajectories were not well documented. A layer of ozone aloft was detected over Blythe (500-600 m above ground level) by aircraft measurements and attributed to transport from the SCAB.

Reible, Ouimette and Shair (1982) published the results of two tracer tests in which both tracer material and pollutants were tracked from the San Joaquin Valley into the Mojave Desert and thence northeastward to Inyokern. This study called particular attention to the influence of the San Joaquin Valley on the desert areas north of the San Gabriel Mountains.



LOCATION MAP OF SEDAB AND LOS ANGELES BASIN
Fig. 2.2.2

2.3 Pressure Gradients

During the summer months the principal driving force for the wind systems in the South Coast and Southeast Desert Air Basins is the pressure gradient directed from the coastal areas into the interior. Synoptic changes from day-to-day influence the specific values each day but the diurnal effect of inland heating is the dominant feature of the wind circulation. Because of strong terrain influences and the effect of the diurnal heating cycle there are great similarities in the wind flow patterns in the area at comparable times of day. Primary variations in wind flow patterns occur on a diurnal rather than day-to-day basis.

Any number of pressure gradients can be used to assess the intensity of the diurnal circulation system. Two commonly used gradients are from Los Angeles International Airport (LAX) to Bakersfield and from LAX to Daggett. Three year average (1976-78) gradients for July-August are plotted in Figure 2.3.1 to document the diurnal variations. Both gradients reach a maximum at 16 PST and show minimum values around 06-08 PST. The gradient into Daggett from LAX is shown to be substantially greater than LAX to Bakersfield on an average basis.

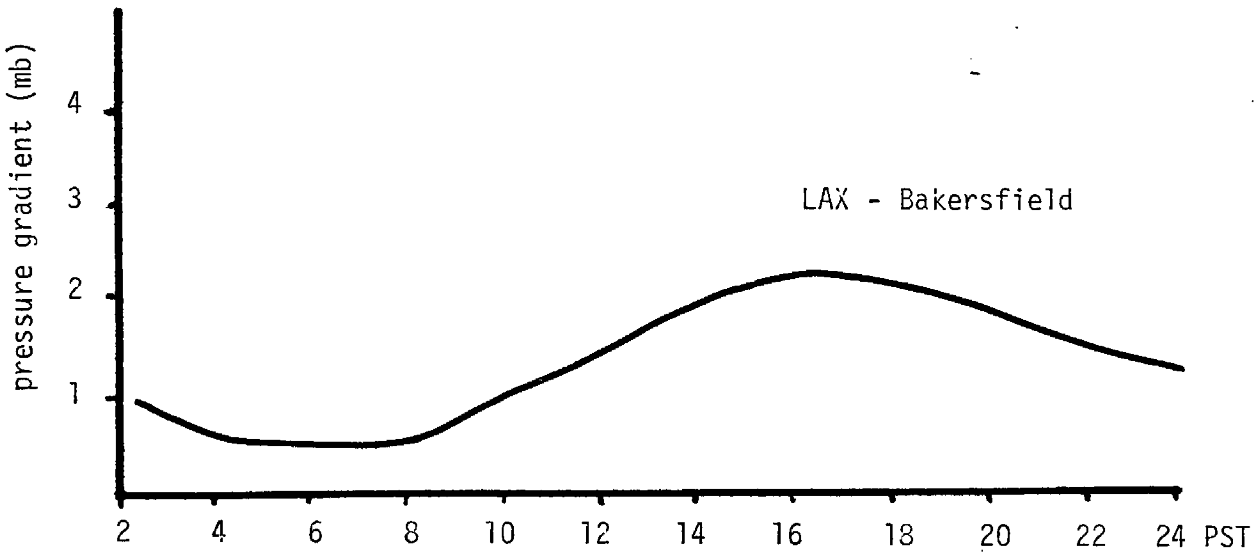
Day to day variations in these pressure gradients as observed at 08 PDT during the 1981 field program are shown in Figure 2.3.2a and b. Three-year average gradients for July-August are also included. The days on which tracer tests were conducted are shown in the figure.

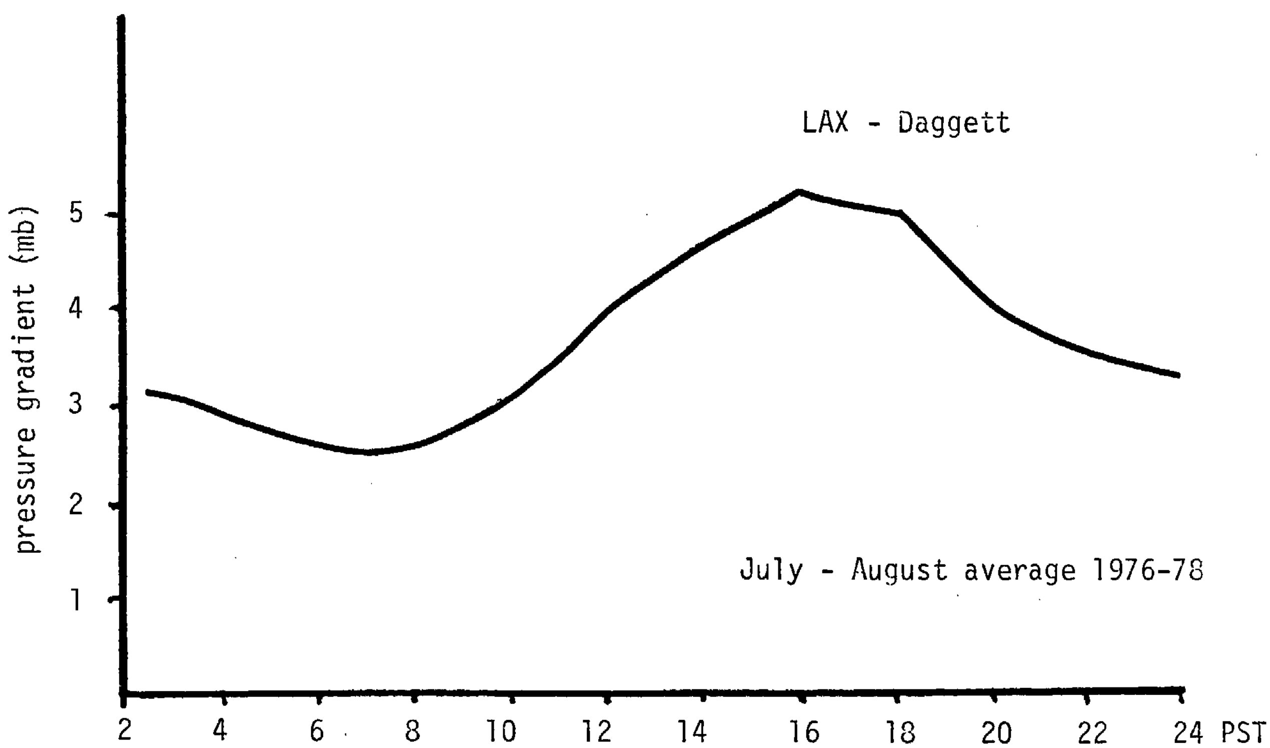
For the purposes of the test program, significant onshore gradients were considered desirable in order that transport into the desert could be assured. As indicated in Figure 2.3.2 only one of the tests (Test 2) was carried out under significantly below normal gradient conditions. The balance of the tests were conducted with near or above normal pressure gradients.

2.4 850 mb Temperatures

An easy reference guide to air pollution potential is provided by the 850 mb temperature (about 5000 ft) in the area of interest. Warm temperatures aloft suggest stability, trapping of low-level pollutants and restricted vertical mixing. Cool temperatures aloft suggest more effective vertical dispersion.

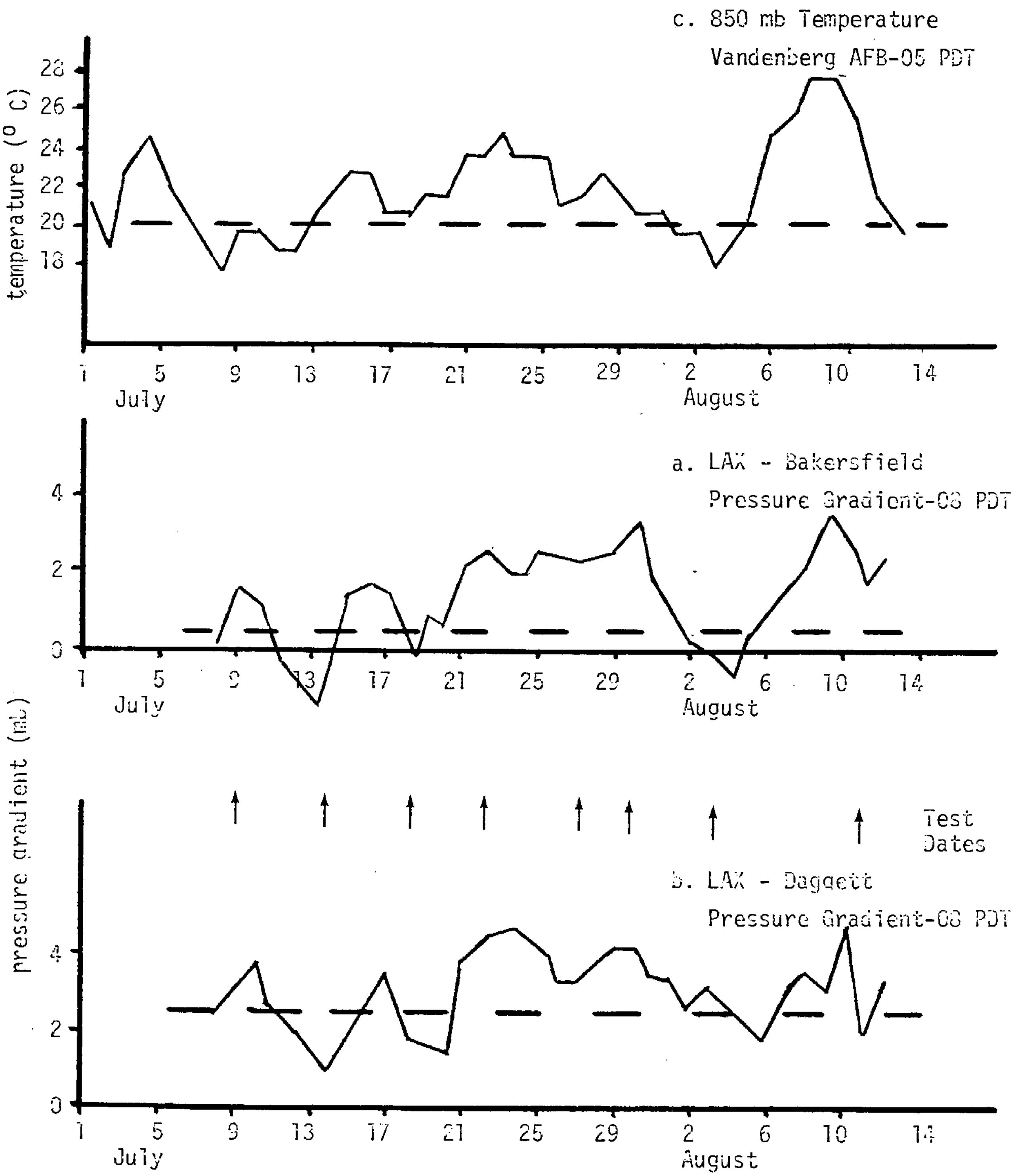
Figure 2.3.2c shows the daily variation in 850 mb temperature as observed at 05 PDT at Vandenberg AFB. Also shown is a three-year average temperature for the July-August period. With the exception of Test 7 all tracer tests were conducted under near or above normal 850 mb temperatures. An unusually warm period occurred late in the field program and resulted in delaying Test 8 until more favorable onshore pressure gradients had been reestablished.





DIURNAL VARIATIONS IN PRESSURE GRADIENT

Fig. 2.3.1



METEOROLOGICAL PARAMETERS - 1981 FIELD PROGRAM

Fig. 2.3.2

It is of some interest to note that there is a considerable positive correlation between 850 mb temperatures and the pressure gradients although with a slight lag, particularly for the LAX to Daggett gradient. Presumably this correlation results from increased inland heating associated with warm temperatures aloft.

2.5 Wind Flow Patterns

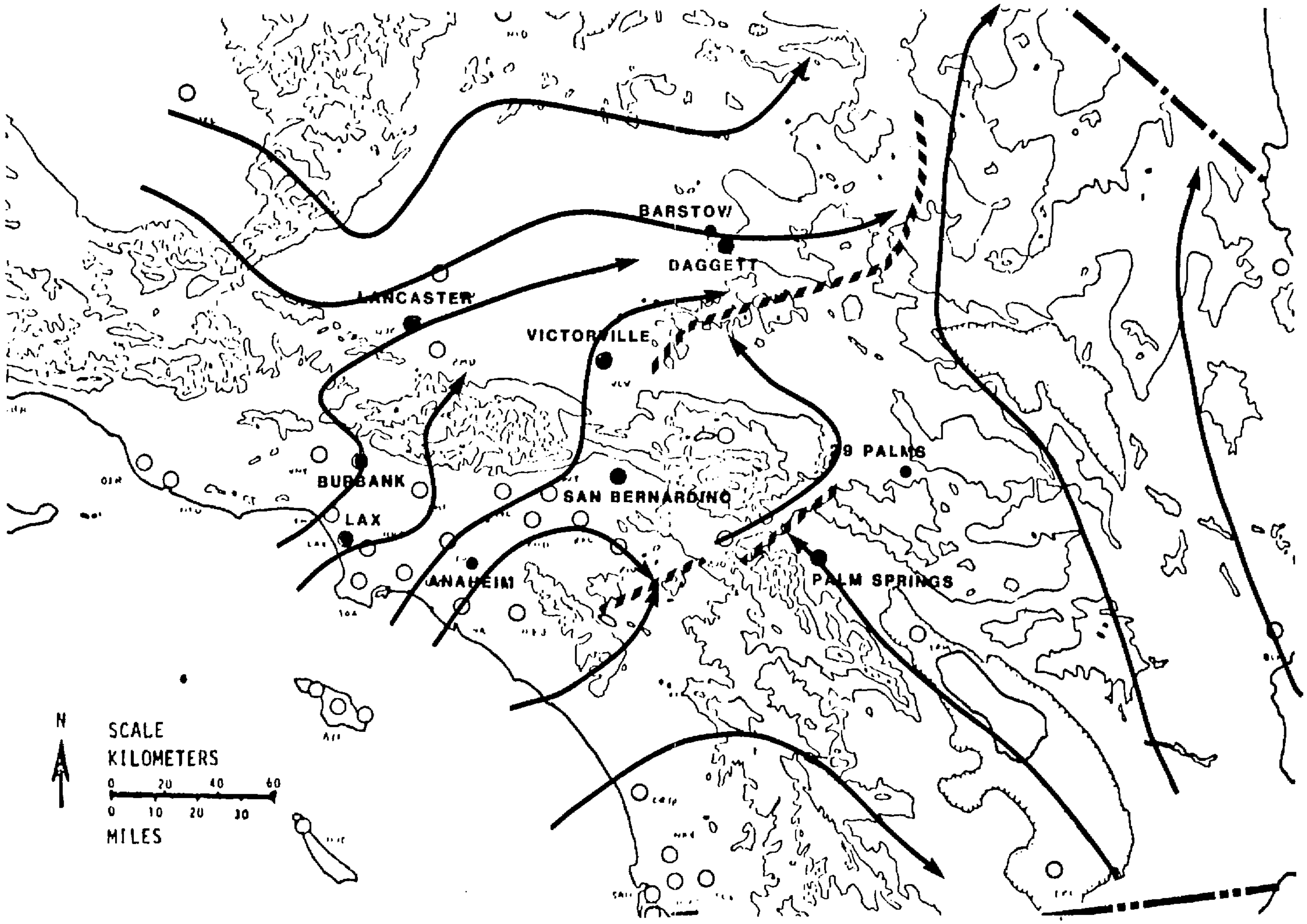
In view of the strong diurnal variations in wind flow patterns it is useful to construct mean streamline charts for various hours of the day. These charts are shown in Figures 2.5.1 to 2.5.7.

Most of the data used in preparing the charts was derived from the period of July-August 1981 when the field program was being conducted. In the Mojave Desert and eastward to the Nevada border, however, an extensive (25 station) wind network was operated in late 1979 and 1980 for the purpose of wind energy assessment (Berry, Hauser and Lane, 1981). These data were provided to the study by the California Energy Commission and proved invaluable in defining the mean flow fields in the desert areas where little wind data are otherwise available. The most frequent wind direction for a particular hour of the day should be a stable statistic from one year to the next so that the 1980 data were used together with the 1981 data to construct the streamlines shown in the figures.

There are a number of significant features shown in the wind flow patterns in Figures 2.5.1 to 2.5.7.

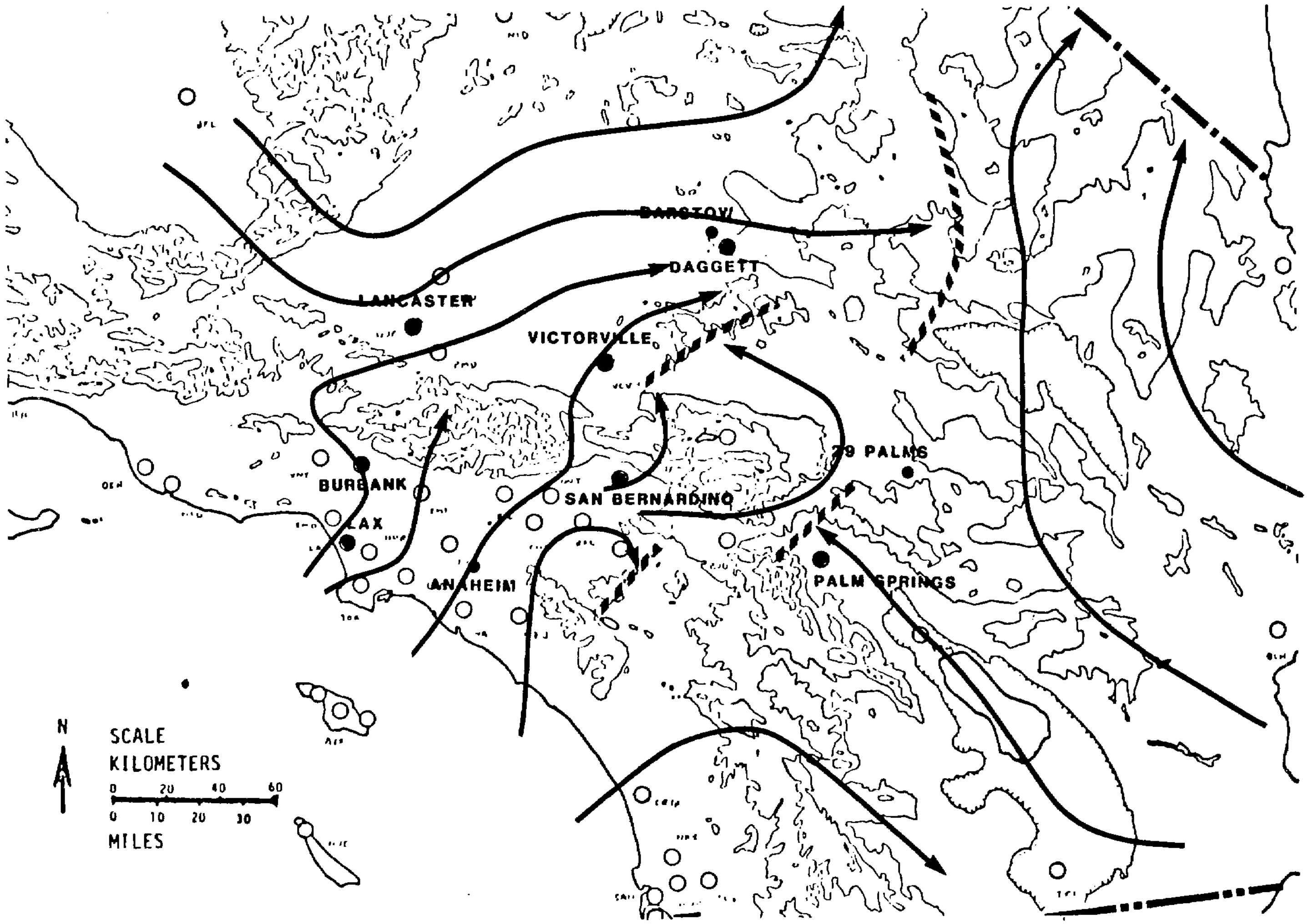
1. Transport through the passes - By 10 PST flow through all of the passes is established on a most-frequent basis. These passes include Soledad/Mint Canyon, Cajon Pass, San Gorgonio Pass, flows through Julian into the southern Imperial Valley and into the Morongo Valley through Yucca Valley. By 24 PST these transport routes are usually cut off with the exception of flow through San Gorgonio Pass.

2. Flow from San Joaquin Valley - Extensive observations for wind energy assessment have recently shown the importance of the San Joaquin Valley flow in the western Mojave Desert. Most-frequent direction arrows in Figures 2.5.1 to 2.5.7 in the western Mojave show the strong influence of the San Joaquin flow at all hours. The trajectory of air leaving Soledad Canyon usually seems to be confined primarily to the southern part of the desert. By 24 PST the flow in the desert is almost entirely due to the San Joaquin Valley influence. There is clearly a zone extending perhaps from west-southwest toward east-northeast, north of which the primary influence is due to air from the San Joaquin Valley and south of which an air trajectory through Soledad Canyon is dominant. This zone shifts north and south from day to day. This question is addressed further in Section 4.



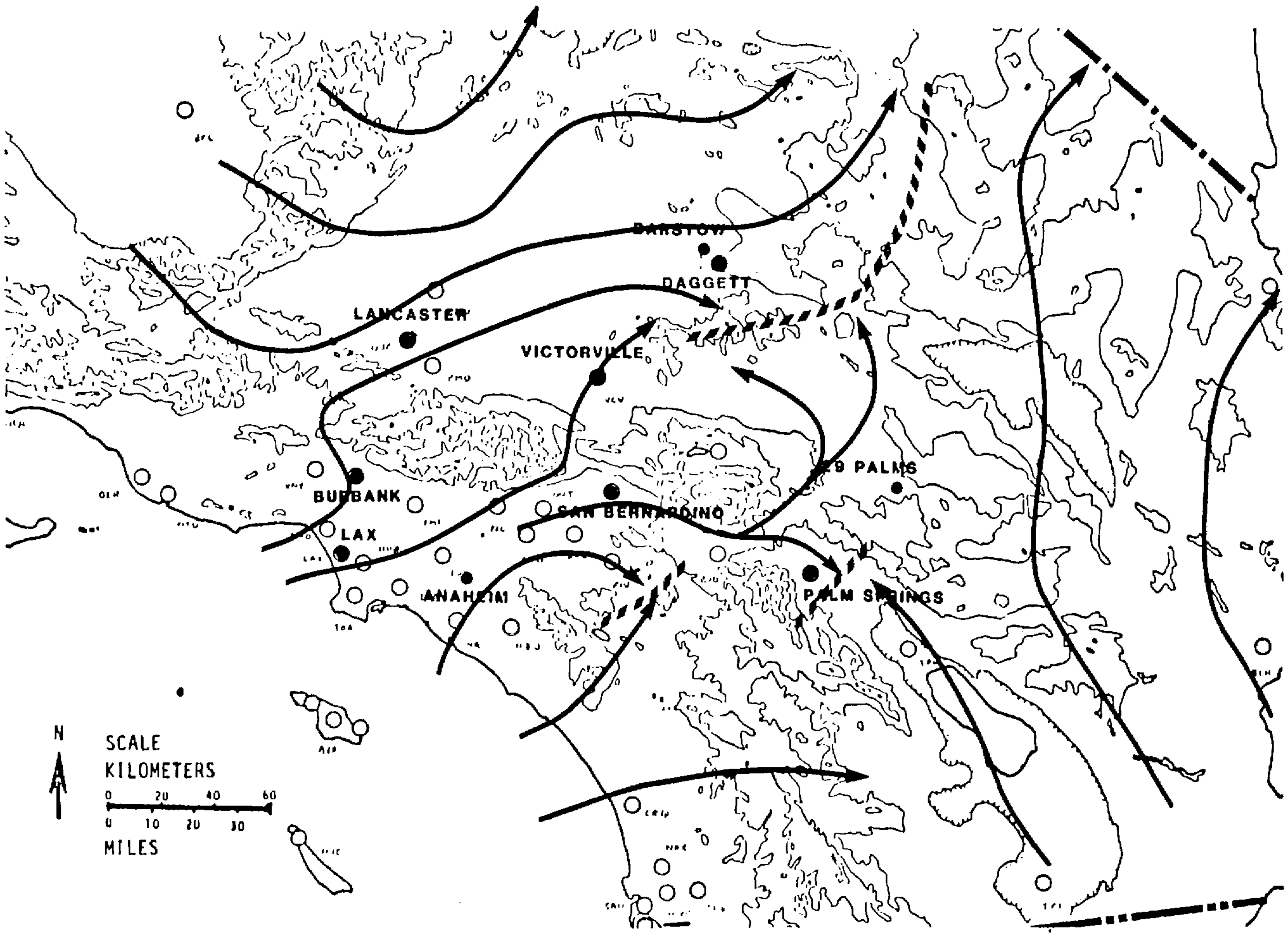
MOST FREQUENT WIND DIRECTION (10 PST) - (JULY - AUGUST)

Fig. 2.5.1



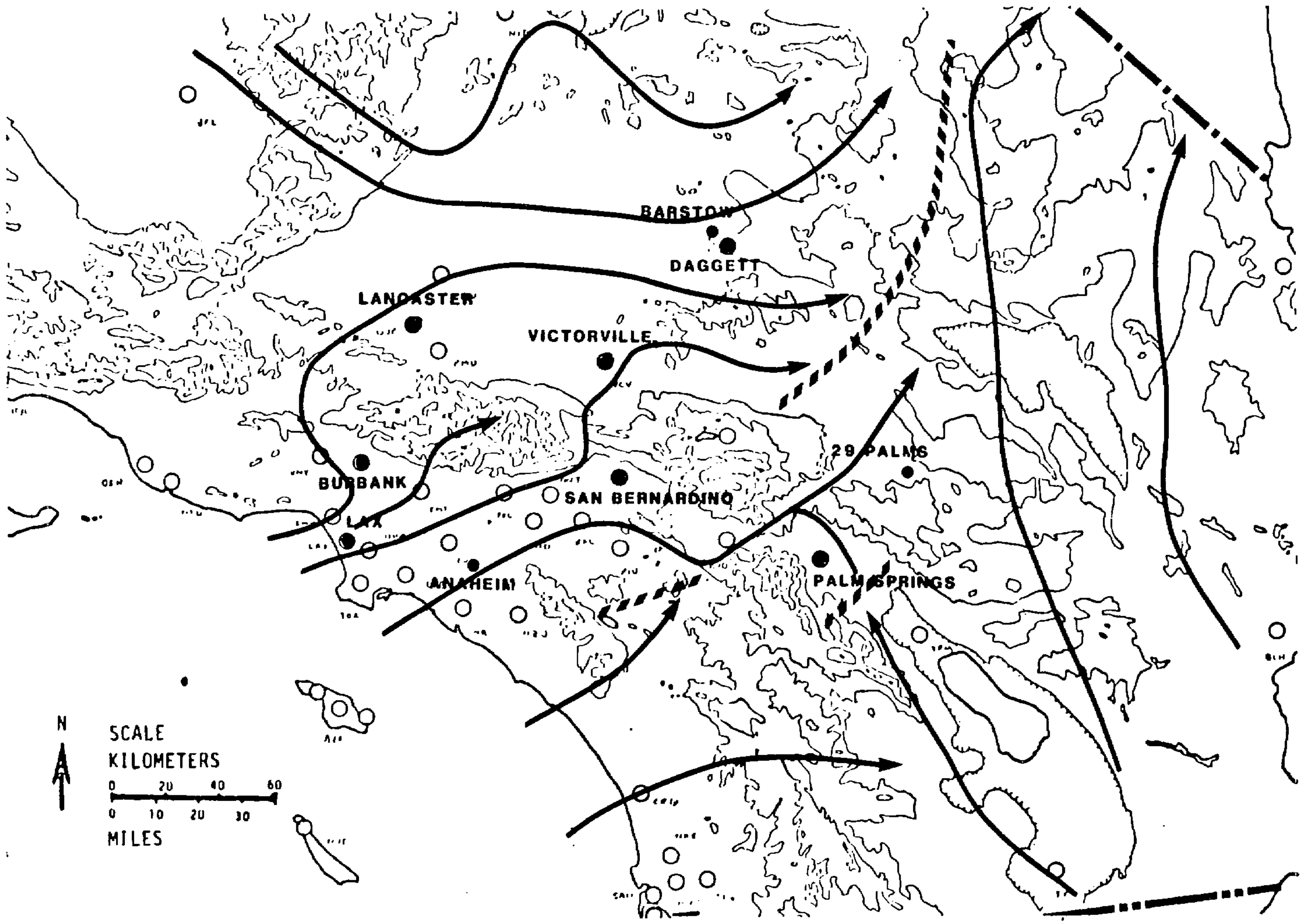
MOST FREQUENT WIND DIRECTION (12 PST) - (JULY - AUGUST)

Fig. 2.5.2



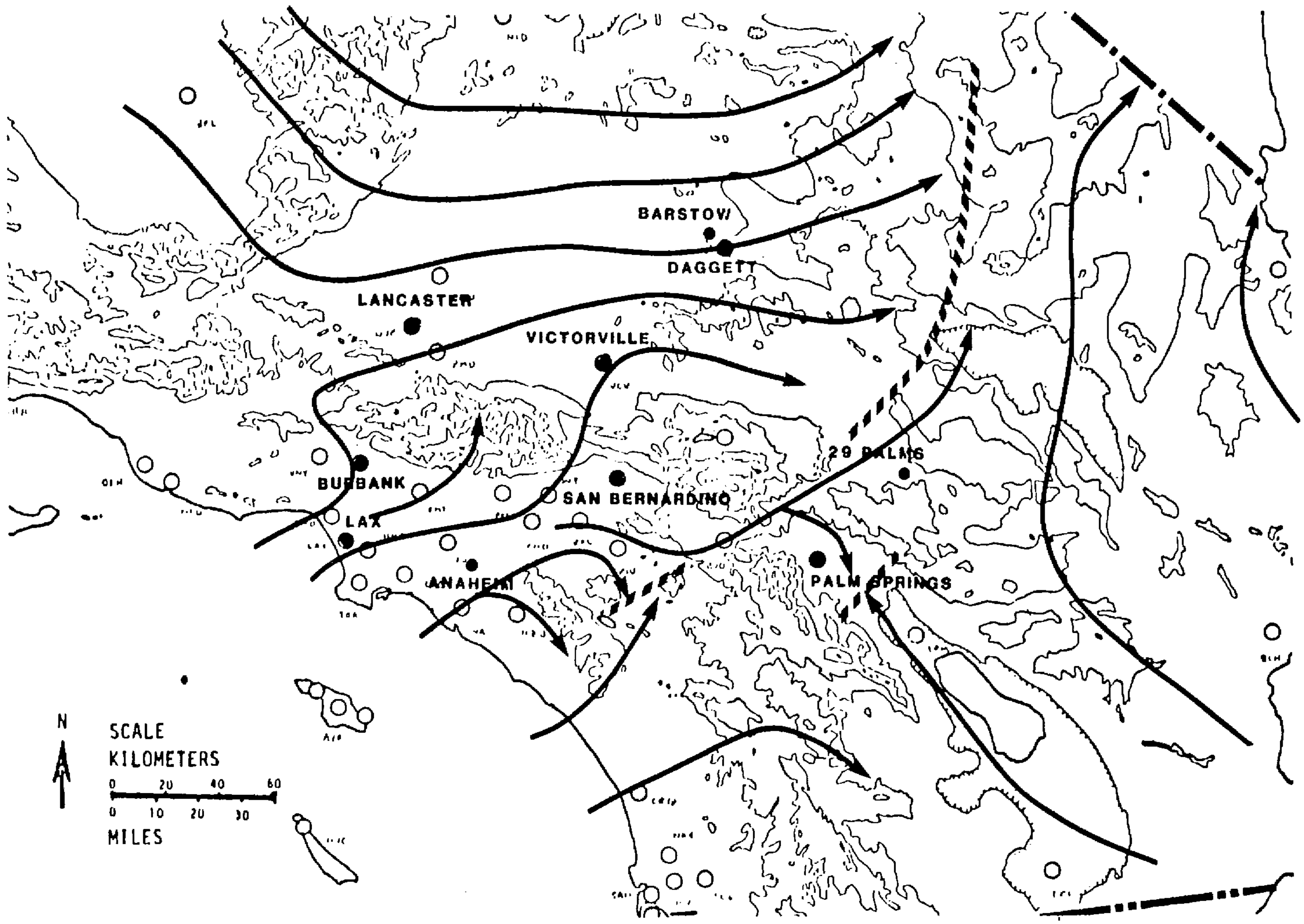
MOST FREQUENT WIND DIRECTION (14 PST) - JULY - AUGUST)

Fig. 2.5.3



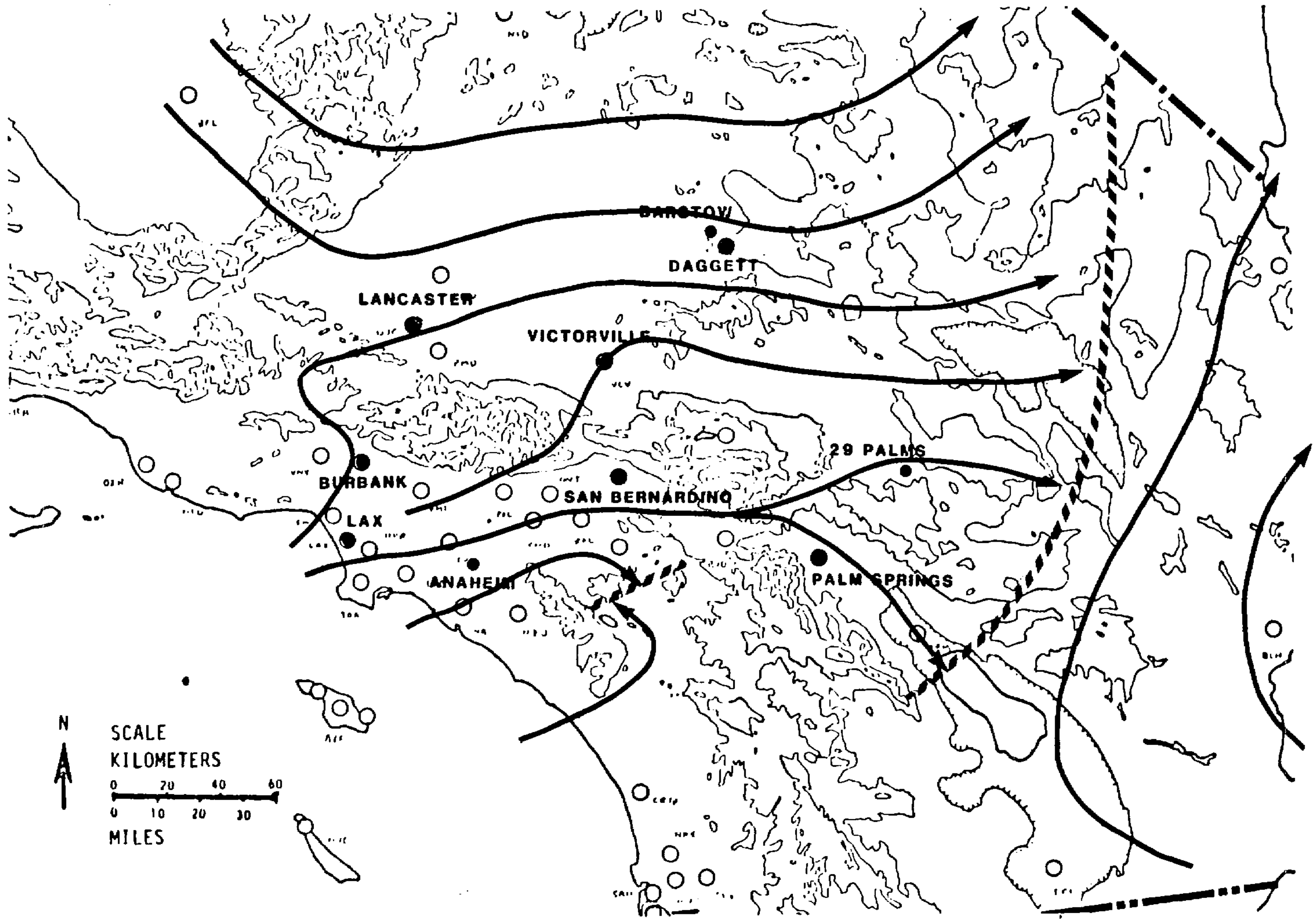
MOST FREQUENT WIND DIRECTION (16 PST) - (JULY - AUGUST)

Fig. 2.5.4



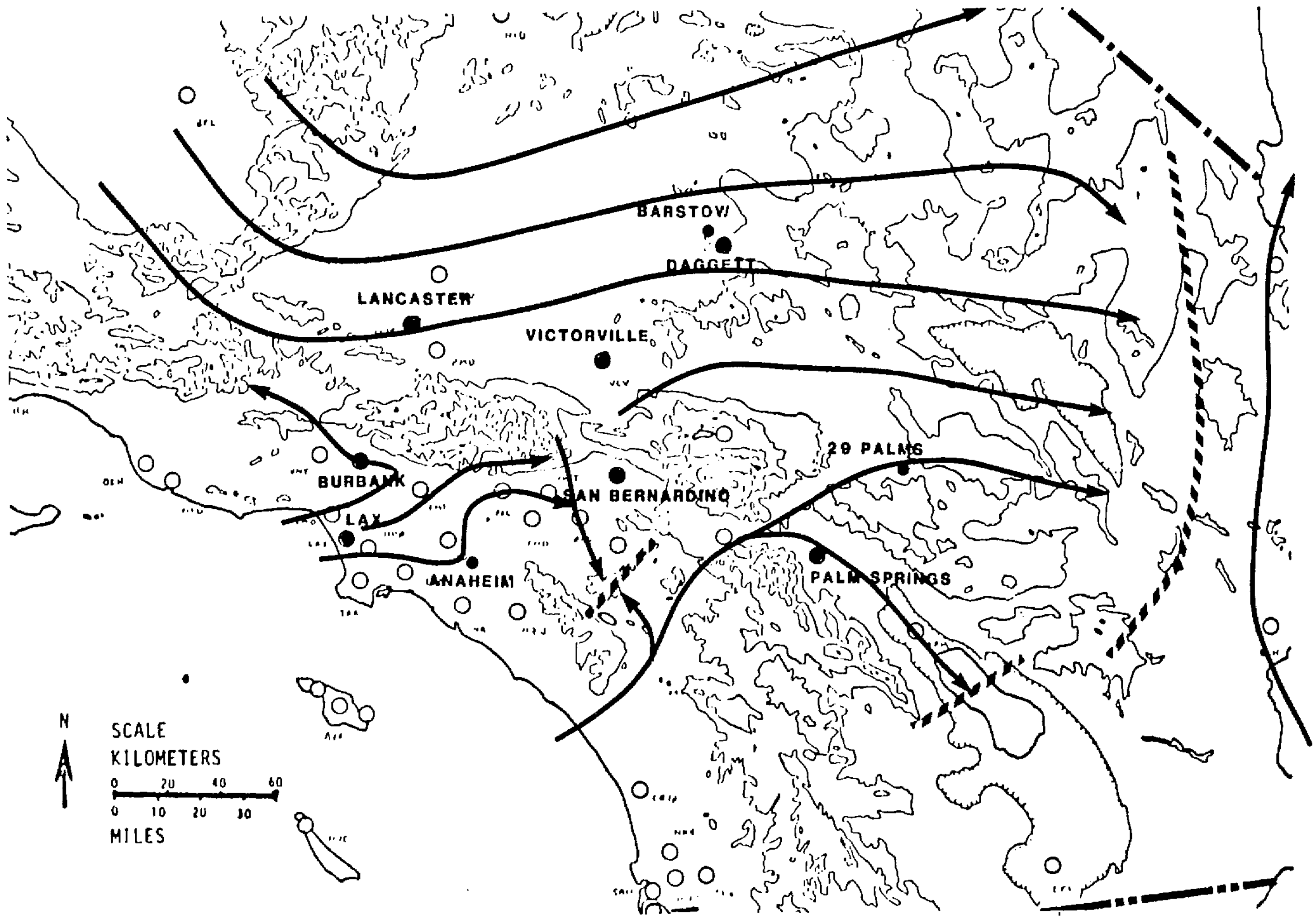
MOST FREQUENT WIND DIRECTION (18 PST) - (JULY - AUGUST)

Fig. 2.5.5



MOST FREQUENT WIND DIRECTION (20 PST) - (JULY - AUGUST)

Fig. 2.5.6



MOST FREQUENT WIND DIRECTION (24 PST) - (JULY - AUGUST)

Fig. 2.5.7

3. Southeasterly flow in eastern California - There is a strong, dominant wind flow pattern from the south and southeast which covers a large portion of the southeastern and eastern sections of the desert. A branch of this flow extends as far north as Palm Springs in the Coachella Valley. The western boundary of this flow moves eastward during the late afternoon and evening but moves back westward by the next morning.

4. Convergence zones - There appears to be an extensive area of convergence in the eastern part of the desert between the westerly and the southerly wind flows. This zone shifts location diurnally depending on the strength of the westerly flow. The farthest eastward extent of the zone in Figures 2.5.1 to 2.5.7 occurs at 24 PST.

   A similar (or part of the same) zone exists in the northern part of the Coachella Valley. Southeasterly winds prevail at Palm Springs most of the day, being replaced by northwest winds in the late afternoon and evening.

   The Elsinore convergence zone is readily apparent to the southeast of Riverside. Northwesterly winds from the Los Angeles Basin oppose southerly winds which bring air inland from the southern coast.

   The El Mirage convergence zone between Palmdale and Victorville was not apparent in the most frequent wind direction analysis. However, it clearly existed on some days and there is a sizeable gap in the observational data in the area where it occurs.

   There is an additional minor convergence zone along the Ord Mountains (south of Barstow) during the morning and early afternoon. Southeasterly winds extend as far west as Lucerne Valley and the southern portions of the Ord Mountains. This wind flow contrasts with the southerly winds at Victorville and the westerly winds at Barstow and Daggett. This zone begins to move eastward after 14 PST and westerly winds dominate Lucerne Valley thereafter through midnight.

2.6 Air Quality Environment

A number of stations in and near the Southeast Desert Air Basin frequently experience high ozone concentrations during the summer months. Table 2.6.1 shows the maximum ozone concentrations observed during the July-August period from 1977 through 1981. The first group of stations shows representative records from several locations in the South Coast Air Basin. These serve as an indication of the severity of the ozone experiences each year.

The second group of stations are the regularly reporting locations in the Southeast Desert and in the mountains separating the two air basins. The third group of stations are those which were installed for the period of the 1981 field program together with China Lake (U.S. Naval Weapons Center) and Lucerne Valley (Southern California Edison Co.) which were available to the study for 1981 only. Maximum concentrations observed during the field program itself are also shown. The latter, compared to observations in previous years, indicate that the field program encountered representative ozone conditions during its period of operation.

Table 2.6.1 shows maximum ozone concentrations greater than 20 pphm at Lancaster, Victorville and Palm Springs which are immediately downwind of three major transport routes into the desert. Concentrations of 30 pphm or more were observed in the passes themselves (Newhall, Cajon and Banning). Maximum ozone concentrations at some of the mountain locations are characteristically high. Lake Gregory experienced 30 pphm or more in each of the five years. Mt. Wilson and Mt. Baldy had maximum values of 29 and 35 pphm, respectively, for the July-August 1981 period. During the period of the 1981 field program Fontana, Lake Gregory and Mt. Baldy all experienced maximum hourly concentrations of 35 pphm.

Table 2.6.2 gives the number of days and hours during which the state ozone standard (10 pphm) was exceeded at a variety of locations in July-August 1981. The standard was exceeded on nearly every day at Fontana, San Bernardino, Lake Gregory and Mt. Baldy. Within the desert itself, maximum ozone concentrations of over 10 pphm were recorded on more than half of the days at Lancaster, Victorville and Palm Springs. Highest numbers of hours with concentrations over 10 pphm were observed at Lake Gregory and Mt. Baldy. These numbers exceeded those of Fontana and San Bernardino, presumably because of the lack of NO_x reductions in the mountain areas. The sharp difference between Lake Gregory and Fawnskin (Big Bear area) should be noted.

Figure 2.6.1 shows a map of the maximum hourly ozone concentrations observed during the period of the 1981 field program (July 8 - August 11). Highest concentrations were observed along the foothills of the San Gabriel Mountains and at Lake Gregory and Mt. Baldy. Intrusions into the desert are indicated at Lancaster, Victorville and Palm Springs.

Table 2.6.1

JULY-AUGUST MAXIMUM OZONE CONCENTRATIONS (pphm)

Location	1977	1978	1979	1980	1981	Field Program 1981
Pasadena-Walnut	32	42	36	33	33	27
Central Los Angeles	20	23	27	21	27	27
Fontana	39	37	39	36	35	35
Newhall	33	31	32	35	26	26
Lancaster	23	27	20	25	21	21
Barstow	16	16	15	15	16	16
Victorville	19	17	16	26	21	21
29 Palms		10	13	12	15	12
Lake Gregory	30	33	34	32	35	35
Banning	27	30	27	26	23	23
Palm Springs	21	20	21	21	19	19
Indio	19	17	17	7	18	18
El Centro	8	12	11	12	10	10
China Lake					11	11
Edwards AFB					18	18
Mt. Wilson			32		29	29
Mt. Baldy					35	35
Cajon Pass					33	33
Daggett					14	14
Fawnskin					15	15
*Lucerne Valley					13	13

* Provided by Southern California Edison Company

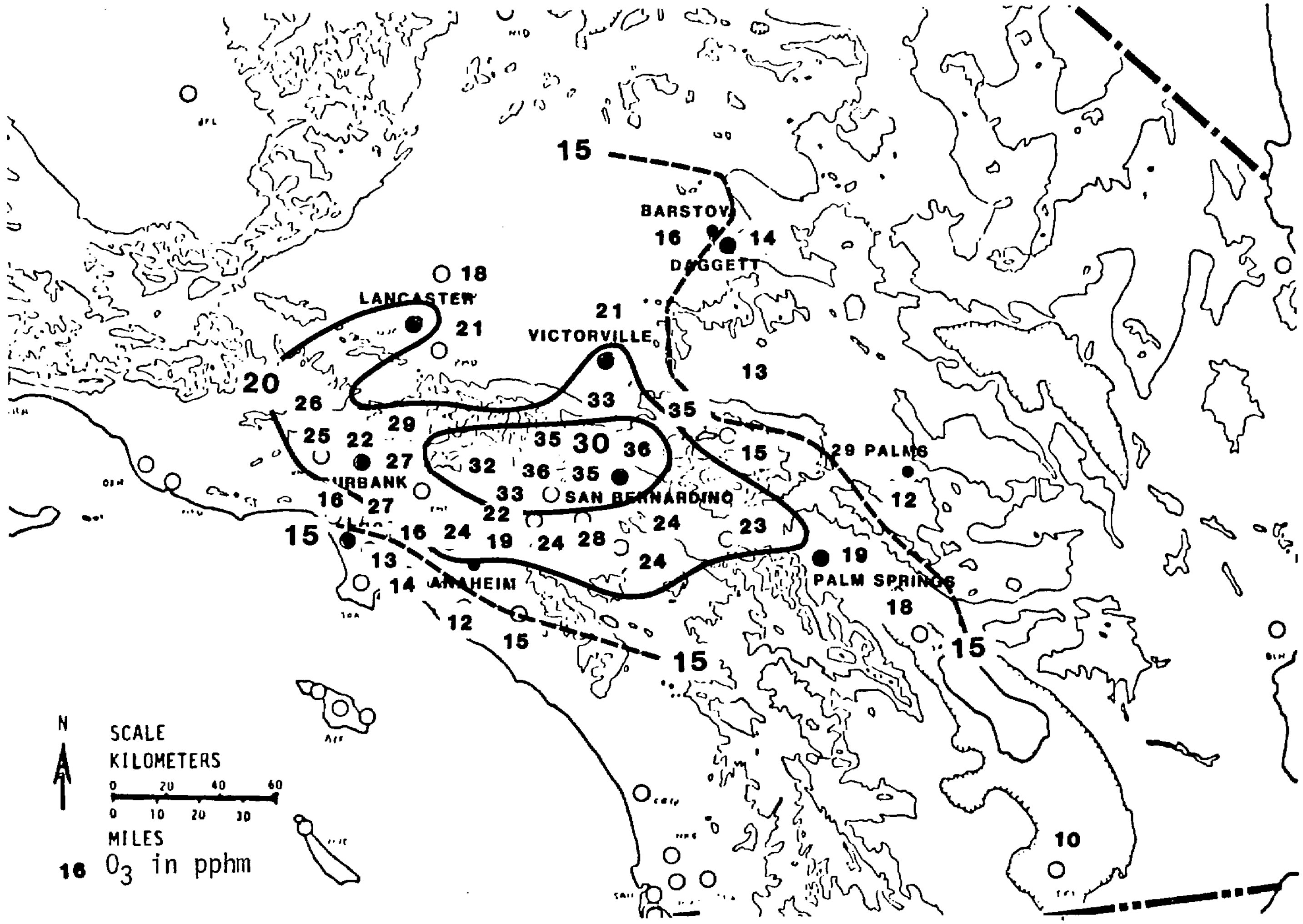
Table 2.6.2

JULY-AUGUST 1981

OZONE CONCENTRATIONS >10 pphm

	Number of Days	Number of Hours	Total Number of Days in Sample
Pasadena-Walnut	55	280	61
Central Los Angeles	44	198	61
Fontana	61	428	62
San Bernardino	61	415	62
Pomona	52	238	60
Azusa	59	349	62
Burbank	55	229	62
Newhall	48	359	62
Lancaster	55	316	62
Barstow	23	58	62
Victorville	34	150	62
29 Palms	12	22	62
Lake Gregory	61	531	62
Banning	33	154	62
Palm Springs	44	208	62
Indio	27	105	62
El Centro	0	0	62
China Lake	1	1	44
Edwards AFB	27	92	42
Mt. Wilson	39	244	42
Mt. Baldy	56	456	56
Cajon Pass	51	262	59
Daggett	19	54	52
Fawnskin	10	20	28
*Lucerne Valley	13	32	60

* Provided by Southern California Edison Company



MAXIMUM HOURLY O_3 CONCENTRATIONS - July 8 to August 11,1981

Fig. 2.6.1

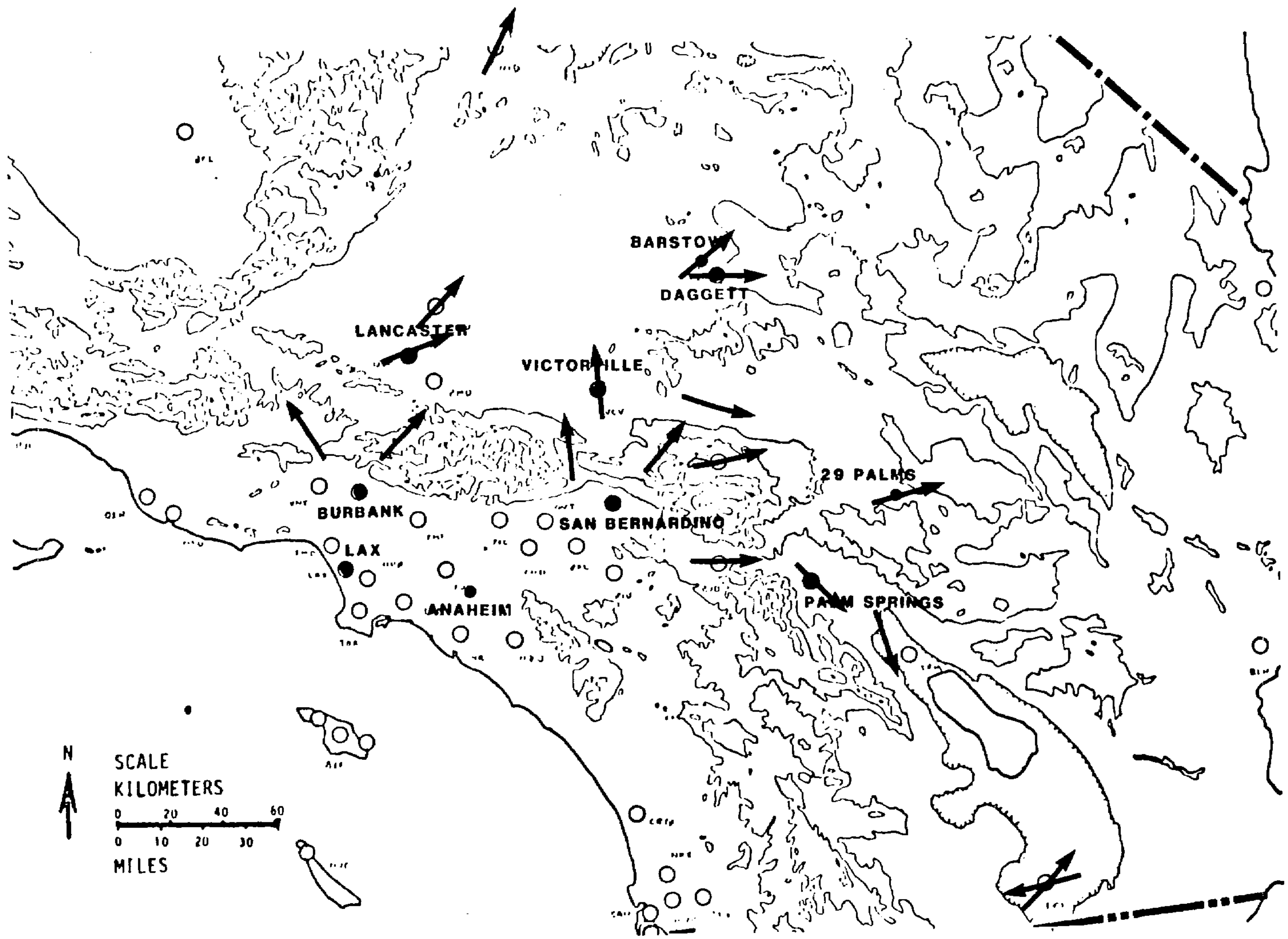
Occurrences of hourly ozone concentrations greater than 10 pphm were tabulated for the desert and near-desert locations for July-August 1981. Wind directions for these hours were then listed to show the prevailing direction during the more significant ozone periods. A map showing the most-frequent wind directions for high ozone occurrences is given in Figure 2.6.2. In order to have sufficient data for a meaningful frequency distribution, occurrences of greater than 8 pphm were used for Inyokern, Lucerne Valley, 29 Palms and El Centro.

Wind data plotted in Figure 2.6.2 suggest the transport of ozone and precursors from the South Coast Air Basin through the passes and up the mountain slopes.

It is useful to compare the time of maximum ozone occurrence at the various reporting locations in the South Coast and Southeast Desert Air Basins. Average ozone concentrations were computed for a large number of stations and the time of highest average concentration has been plotted in Figure 2.6.3. These data show that the time of highest average concentration steadily increases from the central Los Angeles area into the desert locations. This pattern is consistent with the concept of transport from the South Coast Air Basin into the desert regions. Maximum rate of transport should occur perpendicular to the isochrones shown in the figure. Evening maxima are indicated at all locations in the northern Coachella Valley and the eastern Mojave Desert. Both Inyokern and El Centro show midday ozone peaks, indicative of local effects, although Inyokern has a late afternoon, secondary maximum associated with the wind direction shown in Figure 2.6.2. Peak hourly ozone concentrations at Inyokern occur during the late afternoon peak (17 PST) but average concentrations for the period July-August 1981 indicate a maximum at 10 PST.

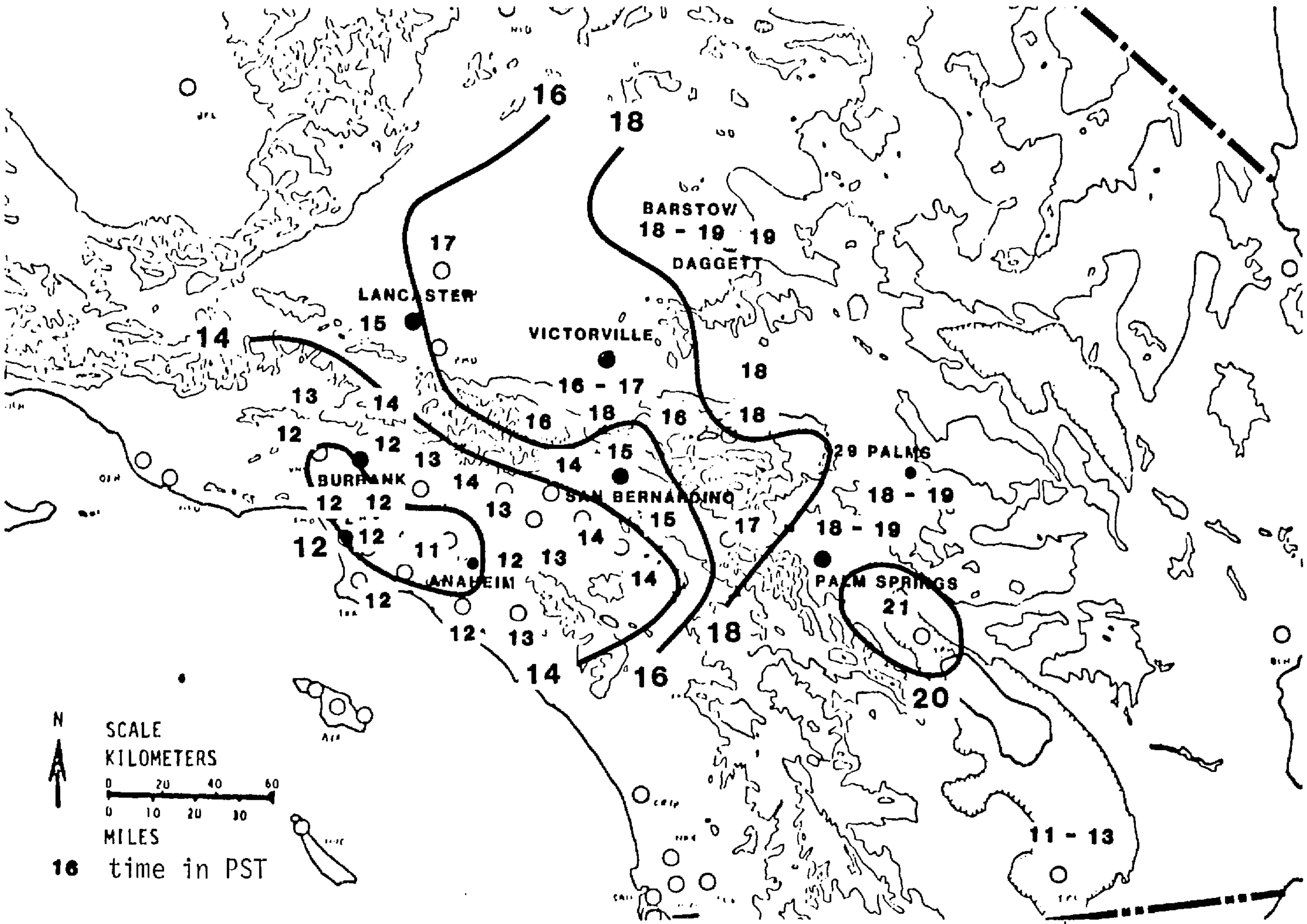
The timing data in Figure 2.6.3 when combined with the streamline charts shown in Figures 2.5.1 to 2.5.7 permit estimates to be made of the trajectories which precede the occurrence of the maximum ozone concentrations. Backward trajectories were constructed from the peak hours shown in Figure 2.6.3 as far back in time as 10 PST. The 10 PST time was chosen as an end of the morning stagnation period when the accumulated pollution begins to move inland.

Estimated backward trajectories are shown in Figure 2.6.4. As indicated, most of the 10 PST end points of the backward trajectories converge on the central Los Angeles basin from Burbank to Anaheim. Two of the trajectories (from Daggett-Barstow and from Edwards AFB) appear to originate in the San Joaquin Valley on a most-frequent basis. The only data point that appears at all out of line is Cajon Pass where a maximum average ozone concentration was observed at 18 PST compared to 15 PST at San Bernardino and 16-17 PST at Victorville. It is suspected that the complex flow structure within the pass may lead to this anomaly. The trajectories and times shown refer to most-frequent wind directions and average ozone concentrations. Considerable day-to-day variation undoubtedly occurs.



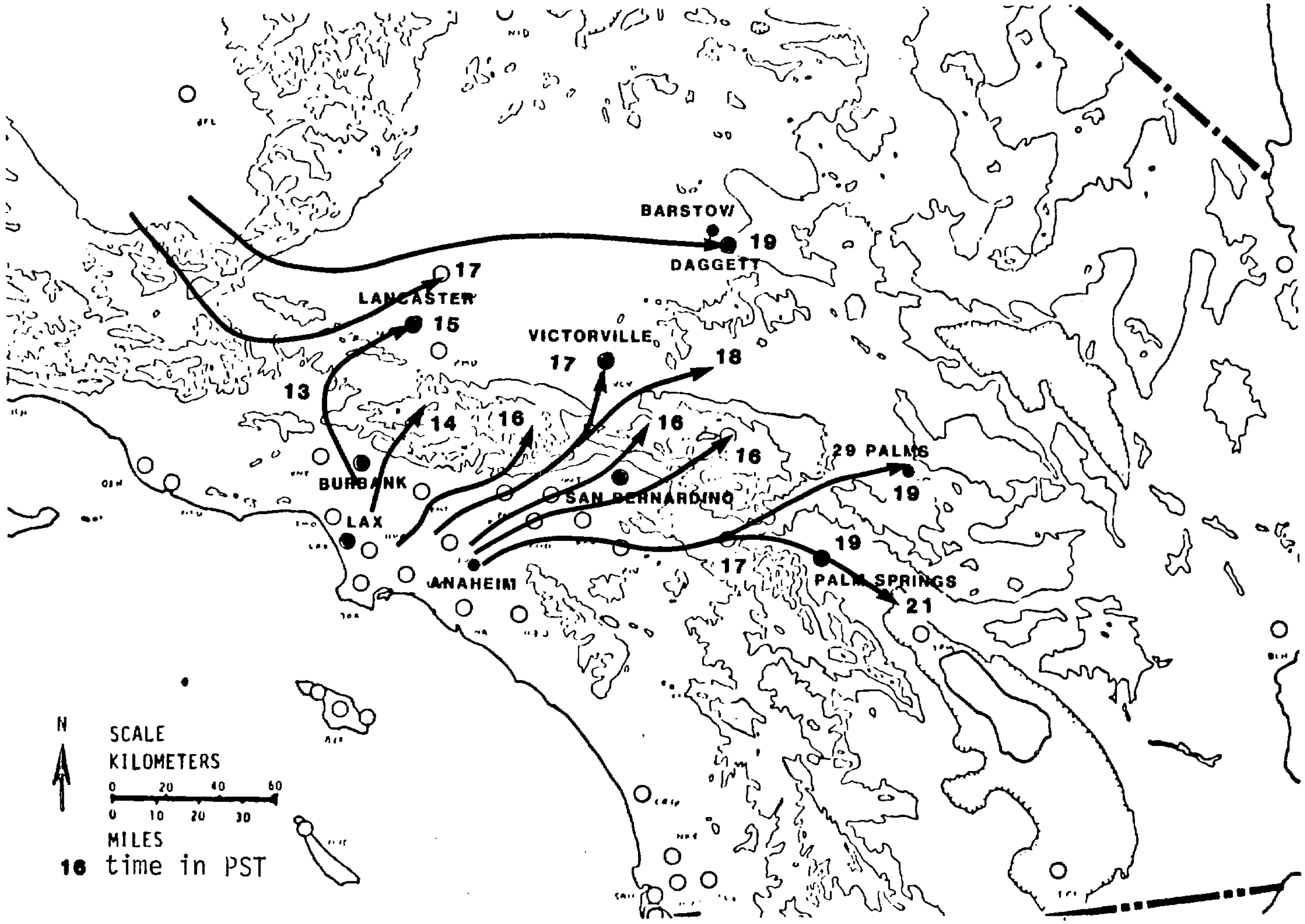
MOST FREQUENT WIND DIRECTION FOR HIGH OZONE PERIODS - (July - August 1981)

Fig. 2.6.2



TIME OF MAXIMUM OZONE CONCENTRATIONS

Fig. 2.6.3



BACKWARD TRAJECTORIES FROM HOUR OF MAXIMUM CONCENTRATION

Fig. 2.6.4

In the Mojave Desert, there is some day-to-day ambiguity in the estimated trajectories and hence in the source regions. On a most-frequent basis, the trajectory into Barstow and Daggett must come from the west. Air from Cajon Pass and Victorville may be transported directly to Barstow-Daggett on some days but not on a most-frequent basis. Similarly, transport from Soledad Canyon into Barstow-Daggett is not ruled out on some days but does not appear to occur on a most-frequent basis.

Edwards AFB is somewhat more ambiguous as a receptor location. Reference to Figures 2.5.5 and 2.5.6 indicates that Edwards AFB and Lancaster are not on the same streamline on a most-frequent basis. The most-frequent trajectory (Figure 2.6.4) therefore shows a source region in the San Joaquin Valley for Edwards AFB. A time difference of two hours between maximum average ozone concentrations at Lancaster and Edwards AFB (Figure 2.6.3) also tends to support this concept. Again, transport through Soledad Canyon is not ruled out but does not appear to occur on a most-frequent basis. This point is covered in greater detail in Section 4.

3. TRACER SUMMARIES

3.1 Test 1 9-10 July 1981, Culver City Release (0600-1000 PDT, 7/9/81)

3.1.1 Meteorology

General

A moderate low pressure trough at 500 mb existed on July 9, slightly offshore of Washington and Oregon (Figure 3.1.1). By July 10 a closed low circulation had developed at 500 mb, centered over northwest Washington. A southwesterly flow was present over California with the pattern remaining relatively unchanged from July 9-11.

Meteorological parameters of interest in and near the Los Angeles Basin are shown in Table 3.1.1. The 850 mb temperature of 20°C at Vandenberg AFB was near average for the month of July. Pressure gradients from LAX to the interior were also near average for this time of year. According to Keith (1980) approximately 65 percent of the morning inversion base heights at LAX are near or below the value of 482 m observed in the UCLA sounding.

In summary, the meteorological environment in the Los Angeles Basin on July 9 was near average conditions for a July day.

Transport Winds

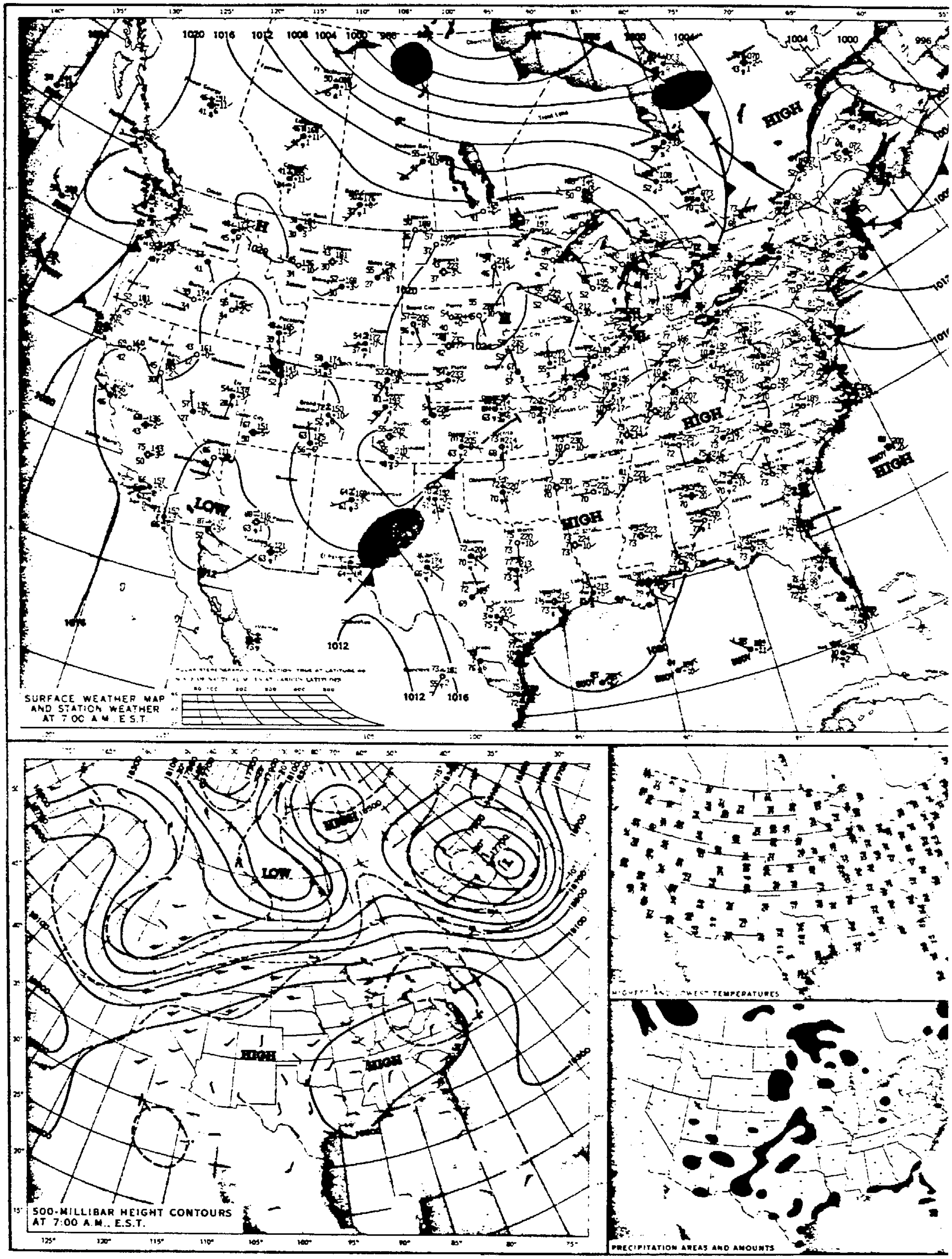
Surface winds at the release location on July 9 are shown in Table 3.1.2:

Table 3.1.2

SURFACE WINDS AT CULVER CITY DURING RELEASE

JULY 9, 1981

Time (PDT)	Direction (°)	Speed (m/s)
06	225	0.6
07	195	0.8
08	225	0.9
09	205	1.4
10	235	1.3



WEATHER MAP

July 9,1981

Fig. 3.1.1

Table 3.1.1

METEOROLOGICAL PARAMETERS

JULY 9, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	20.0°C
Edwards AFB	(0530 PDT)	25.9
Ontario	(0830 PDT)	23.8
UCLA	(0600 PDT)	22.0
Pressure Gradients	(0800 PDT)	
LAX - Daggett		3.1 mb
LAX - Bakersfield		1.8
Maximum Surface Temperature		
Ontario		94°F (34.4°C)
Palm Springs		111 (43.9)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	16.6°C (482 m)
Rialto	(0700 PDT)	18.9 (Surface)
Ontario	(0830 PDT)	19.5 (500 m)
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	23.1°C (1195 m)
Rialto	(0700 PDT)	24.4 (1200 m)
Ontario	(0830 PDT)	24.1 (1280 m)

* All heights are msl

Surface winds at Culver City during the release period were consistently onshore but with low velocities. This permits the initial tracer concentrations to build up substantially prior to moving inland as the sea breeze increases.

Surface winds at several key locations on July 9-10 are shown in Table 3.1.3. Winds at Lancaster, Victorville and Palm Springs tend to reflect the effects of surface transport out of the basin into the desert areas. The wind flow at Lancaster was directed from Mint Canyon into the desert throughout the entire period of July 9-10. Note that the flow was significantly stronger on July 10. At Victorville, flow through Cajon Pass reaches Victorville from the south to southwest. On July 9 this flow pattern existed from 12 PDT to 24 PDT. On July 10, however, the flow during the afternoon was from a westerly direction, probably representing primarily a transport across the Mojave Desert rather than from Cajon Pass.

At Palm Springs, flow from San Gorgonio Pass frequently reaches Palm Springs in the early evening in an abrupt fashion. On July 9 this flow from the northwest began at 17 PDT but was delayed until 19 PDT on July 10. During the day prior to the arrival of the air from San Gorgonio Pass the wind flow at Palm Springs is generally from an east to southeast direction.

Mixing Heights

Mixing heights were obtained from a variety of sources for each day of the tracer program. These heights were observed at two locations in the Los Angeles basin by rasonde measurements. The air quality aircraft made a number of soundings on each flight day from which mixing heights could be obtained. Lastly, the use of maximum surface temperatures and a temperature sounding from a nearby location permits an estimate to be made of the maximum mixing depth that should be expected for that day. These estimates give an indication of the extent of upward dilution that can occur on each day. The observed and estimated mixing heights for July 9 are given in Table 3.1.4.

Although the mixing layer was rather shallow at UCLA, much deeper layers were observed and predicted in the inland areas. All of the desert observations show mixed layer tops near 1400-1500 m, similar to the maximum predicted for Ontario and San Bernardino. The influence of the mountains on mixing height is shown by heights of 1750-1800 m at Lake Gregory, Lake Arrowhead and near Cajon Pass. Downwind in the desert the mixed layer top was at a lower altitude.

The effect of a compressed flow pattern over the ridges is shown by a layer depth of only 450 m at Lake Gregory and 200 m at Lake Arrowhead. Pibal wind data support this observation and indicate a shallow layer of high winds accompanying the pollutants as they pass over the ridges.

Table 3.1.3

SURFACE WINDS - JULY 9-10, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	310°/ 5.1 m/s	Calm	-
08	230 / 5.1	210°/1.0 m/s	Calm
10	260 / 7.2	300 /0.5	130°/5.1 m/s
12	230 / 5.1	200 /0.5	090 /2.6
14	240 /10.8	160 /3.1	090 /7.2
16	240 /10.8	230 /5.1	100 /4.6
18	250 / 9.3	210 /4.6	290 /7.7
20	250 / 7.7	220 /4.1	290 /7.7
22	240 / 5.7	220 /1.5	290 /9.3
24	250 / 5.7	220 /2.6	-
02	250 / 5.1	Calm	-
04	250 / 4.6	Calm	-
06	250 / 7.7	Calm	-
08	260 / 5.1	Calm	060 /2.1
10	240 /13.9	050 /0.5	090 /3.6
12	240 /10.3	260 /2.1	070 /7.7
14	240 / 9.3	290 /1.0	090 /5.7
16	240 /12.9	230 /5.1	090 /5.7
18	250 /12.9	280 /6.2	120 /5.7

Table 3.1.4

MIXING HEIGHTS - JULY 9, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	482 m	150 m
	1200	482	150
Ontario	0830	Surface	290
	1430	760	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Highland	1542 PDT	1400 m	500 m
Lake Gregory	1602	1800	1350
Hesperia AP	1615	1400	900
Hesperia Intsct.	1648	1500	1200
W side Cajon Pass	1713	1800	1300
I-10 and 111	1809	1400	300
Lake Arrowhead	1843	1750	1550

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	1300 m	290 m
San Bernardino	1495	360
Edwards AFB	2135	725

Visibility observations, particularly in the eastern basin, are freqently an excellent indicator of the overall behavior of the mixing layer. Dramatic improvements in visibility during the period of maximum surface heating usually indicate that the inversion has been broken. Visibility observations for San Bernardino and Ontario for July 9 are summarized in Table 3.1.5. Visibilities at both airports were restricted throughout the day, indicating no important elimination of the inversion.

Table 3.1.5

OBSERVED VISIBILITIES - JULY 9, 1981

Time (PDT)	San Bernardino	Ontario
10	5 miles	2-1/2 miles
12	3	4
14	7	4
16	7	6
18	7	7

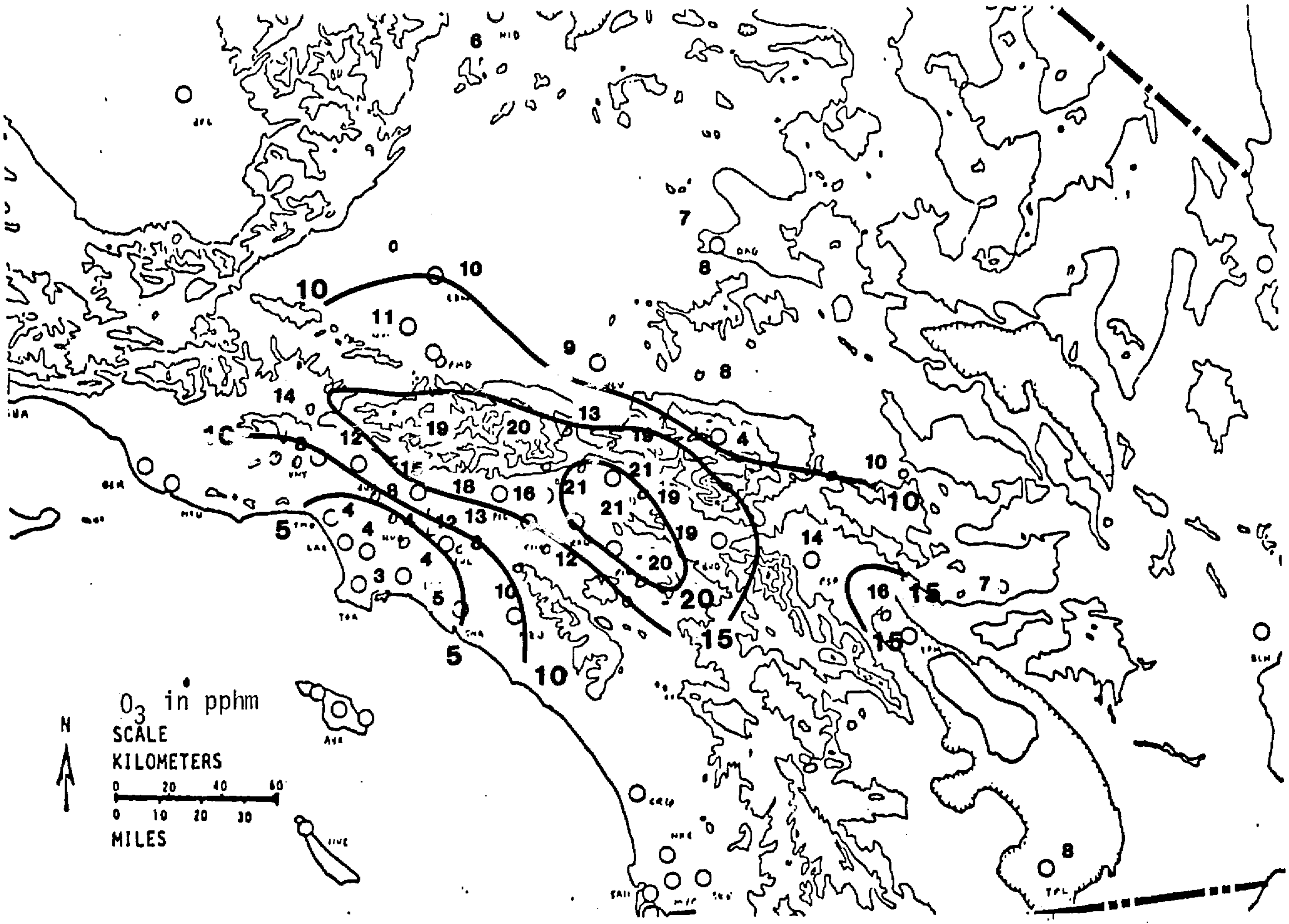
3.1.2 Regional Pollutant Levels

A map of the peak hourly ozone concentrations in the Los Angeles basin and the desert areas is shown in Figure 3.1.2. Peak values of 21 pphm were recorded at Fontana, San Bernardino and Riverside. Mt. Baldy and Perris experienced maximum hourly concentrations of 20 pphm. Highest concentrations in the desert areas were at Indio (16 pphm) and Palm Springs (14 pphm). Concentrations in the Mojave Desert were below average for the month.

A map of the time when the peak ozone concentration occurred is given in Figure 3.1.3. Contours have been drawn at two-hour intervals to show the pattern of the occurrences. This pattern provides an indication of the direction of transport of the ozone since the pollutant should tend to move perpendicular to the isochrones.

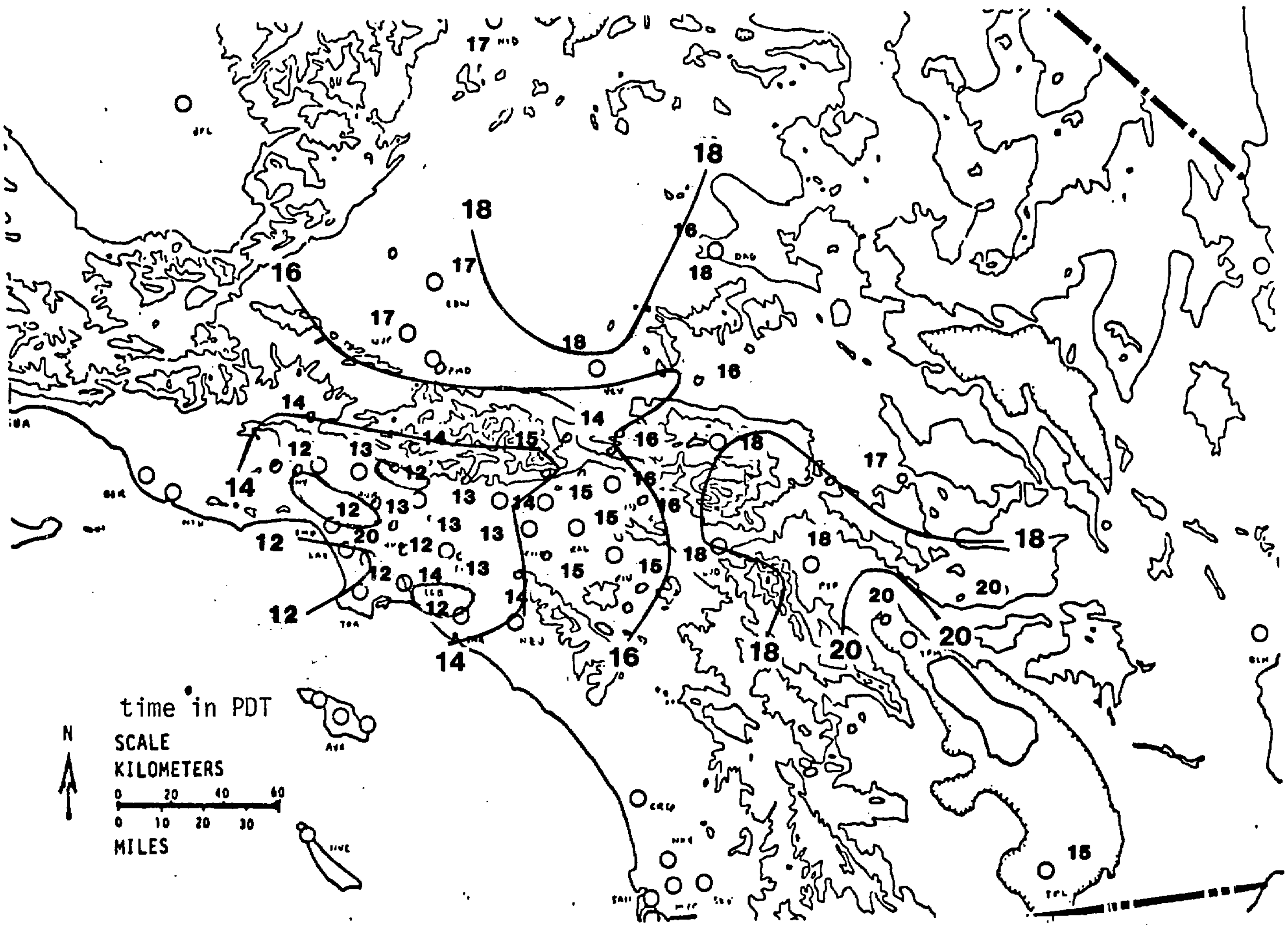
As is customary, the metropolitan Los Angeles area shows the earliest occurrence of peak ozone concentrations (about 12 PDT). All of the desert observations, with the exception of El Centro, show peak hourly values occurring between 16 and 20 PDT. The late arrival of the ozone peak suggests the transport of pollutants from the basin into the desert. Transport through each of the three passes is documented by successively later peak times; Newhall - Lancaster, Fontana - Victorville and Redlands - Palm Springs - Indio. The isochrone along the San Gabriel Mountains tends to be oriented in an east-west direction, suggesting transport up the slopes from the Pasadena - Azusa area.

Figures 3.1.4 and 3.1.5 show plots of hourly ozone concentrations on July 9 for a number of locations at the boundary of the Los Angeles basin and in the desert.



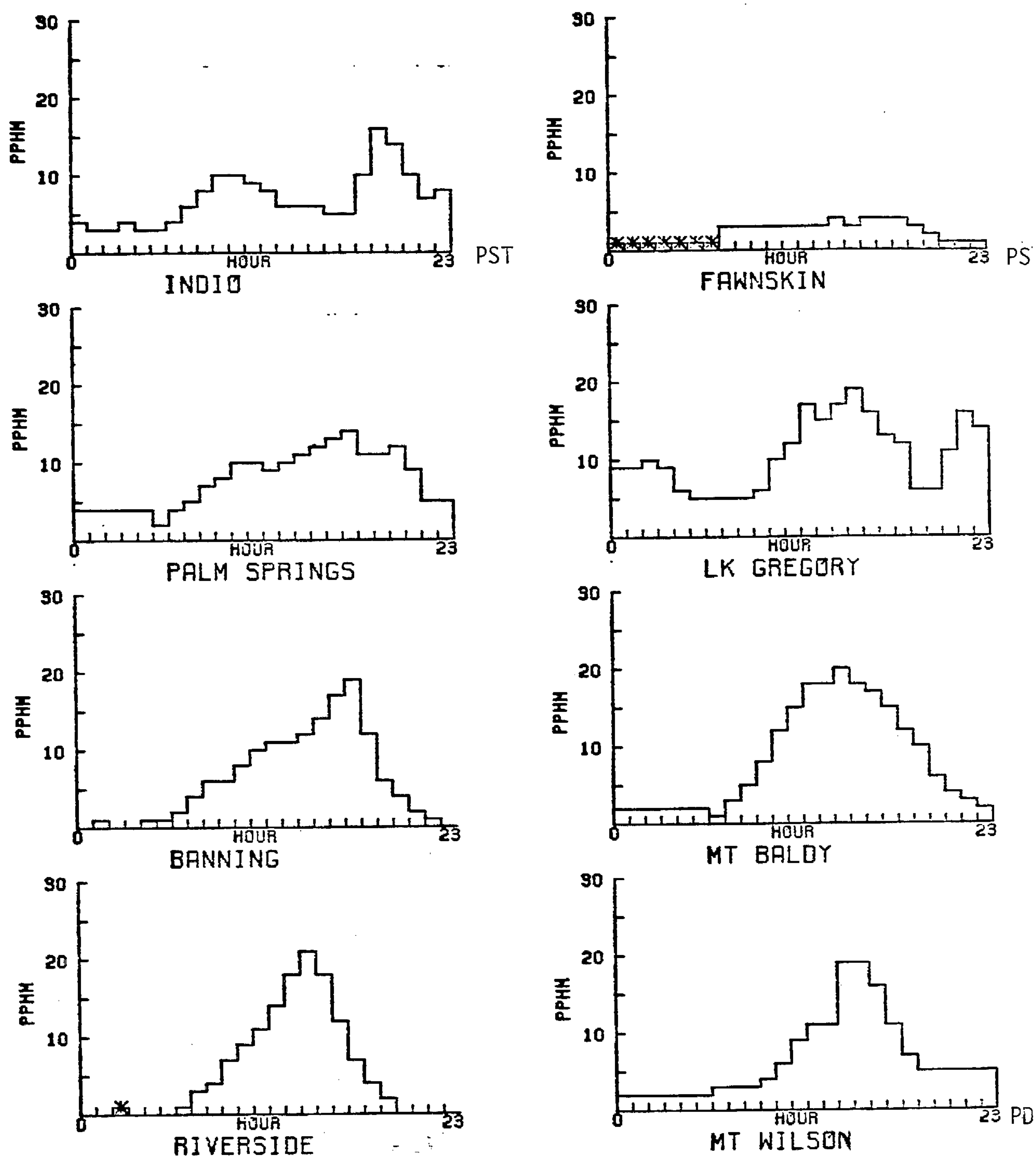
MAXIMUM HOURLY OZONE CONCENTRATIONS - July 9,1981

Fig. 3.1.2



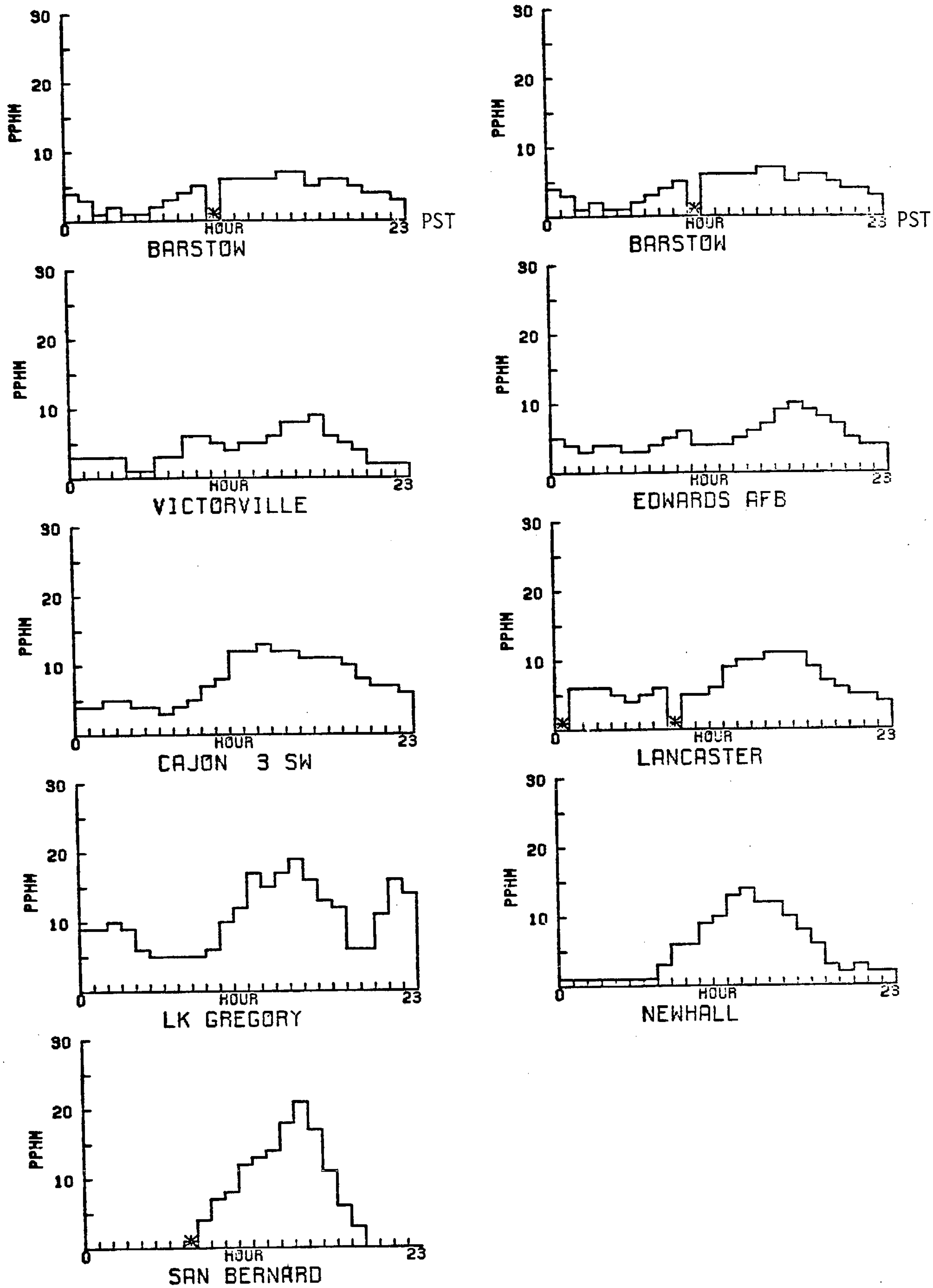
TIME OF HOURLY MAXIMUM OZONE CONCENTRATION - July 9,1981

Fig. 3.1.3



HOURLY OZONE CONCENTRATIONS - July 9,1981

Fig. 3.1.4



HOURLY OZONE CONCENTRATIONS - July 9,1981

Fig. 3.1.5

In Figure 3.1.4 the hourly plots for Indio and Palm Springs show a bimodal distribution, one near noon representing local ozone generation and the later peak representing the transport from the Los Angeles basin. Note the time progression of the ozone peaks from Riverside through Banning to Palm Springs and Indio. At Indio the arrival of the transported ozone is quite abrupt, suggesting that the forward edge of the pollution arrives at Indio somewhat in the fashion of a miniature cold front.

The second set of plots in Figure 3.1.4 show the hourly ozone characteristics at the mountain stations. All stations show peak ozone values between 14 and 18 PDT. In view of the observed time of occurrence and the lack of local precursors, it is clear that the ozone (and precursors) are advected up the slopes from the basin area. The peak concentrations in the mountain areas generally occur within one or two hours of the nearest basin location. Fawnskin (Big Bear Lake) shows only a minimal transport peak at 18-19 PDT in comparison to the other locations.

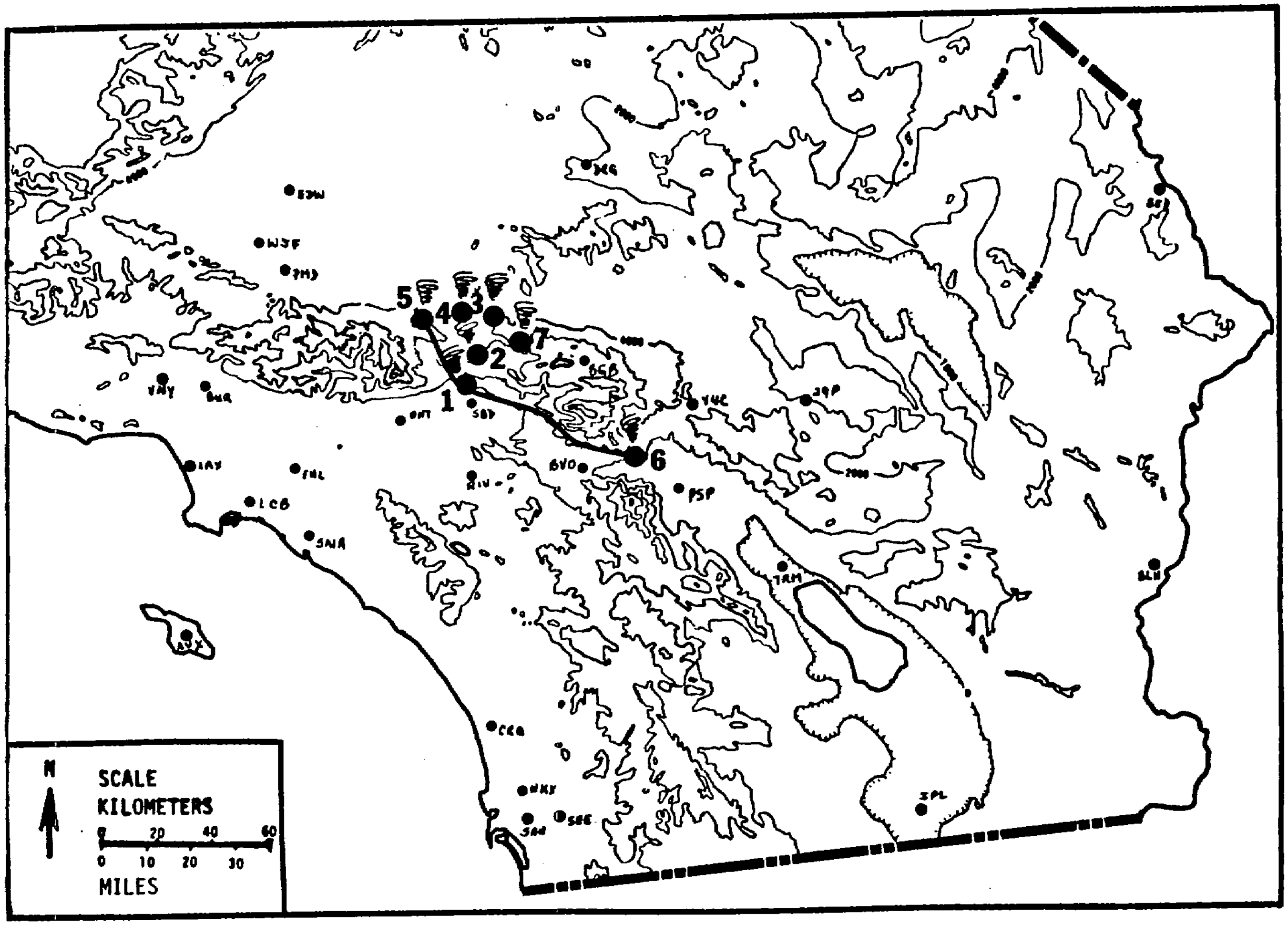
At Lake Gregory, Mt. Baldy and Mt. Wilson the hourly ozone concentrations begin to increase in the forenoon. The peak hour at each location seems to be determined by the timing of the transport of the peak concentrations eastward within the basin itself. The increase in ozone in the late evening is probably associated with an ozone layer aloft advected into the area.

Figure 3.1.5 follows the ozone histories along two transport routes; San Bernardino to Barstow and Newhall to Barstow. The transport through Cajon Pass into Victorville is apparent from the plots. Victorville shows evidence of a minor peak in the late forenoon from local effects. Transport into Barstow was not very apparent on this day. The transport route from Newhall to Edwards AFB is also apparent from the time progression of peak ozone occurrences.

3.1.3 Aircraft Sampling - July 9, 1981

The MRI air quality aircraft sampled at a variety of locations around Cajon Pass and San Gorgonio Pass on July 9. A map of the sampling locations is shown in Figure 3.1.6. Spirals and horizontal traverses are distinguished appropriately on the map. A list of sampling locations corresponding to those in Figure 3.1.6 is given in Table 3.1.6. More detailed descriptions of the flight segments are shown in Table 3.1.7.

Figure 3.1.7 shows the aircraft sounding made at Highland at 1542 PDT. A well-mixed layer is indicated to about 1400 m (msl) with much cleaner air aloft. Peak ozone readings in the mixed layer were about 21 pphm. A subsequent spiral at 1602 PDT was made over Lake Gregory (Figure 3.1.8) and immediately downwind of Highland. The sounding could not be continued to the surface but indicates a pollutant layer top of about 1750 m (msl) which would make the depth of the layer about 375 m above ground. In comparison



MRI SAMPLING FLIGHT - July 9,1981

Fig. 3.1.6

Table 3.1.6

9 July 1981 Tape #251

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°09.2'	117°17.0'	Highland
2	34°14.5'	117°16.0'	Lake Gregory
3	34°22'	117°14.0'	East of Hesperia
4	34°20.5'	117°26.0'	Hespe Intersection Cajon Pass
5	34°22.0'	117°33.0'	West of Cajon Pass Pear Blossom Hwy.
6	33°55.2'	116°40.5'	Intersection of Hwys I10 & 111
7	34°15.5'	117°11.0'	Lake Arrowhead

Table 3.1.7

MRI FLIGHT SUMMARY

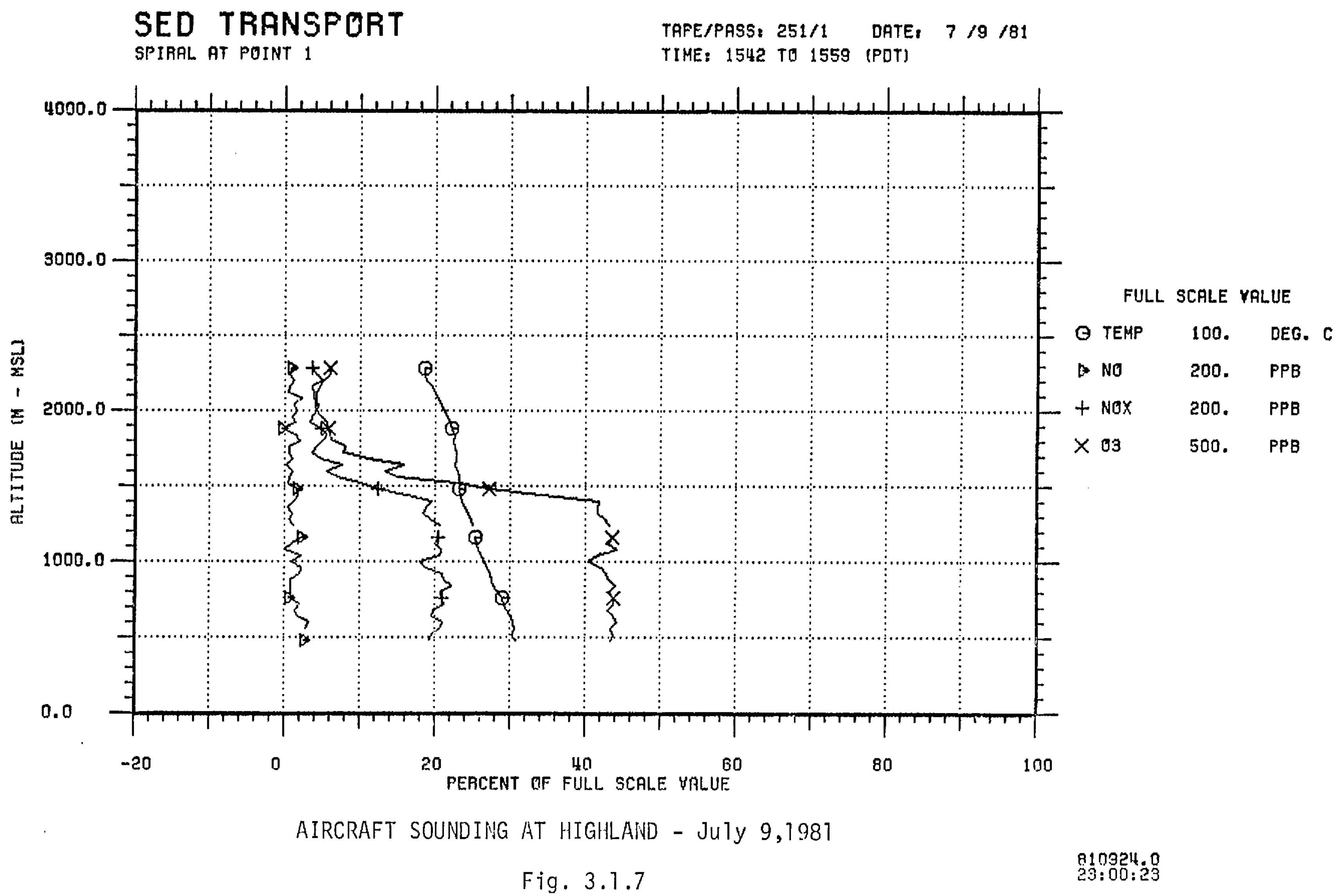
SOUTHEAST DESERT OZONE TRANSPORT STUDY

Date: July 9, 1981

Tape #: 251

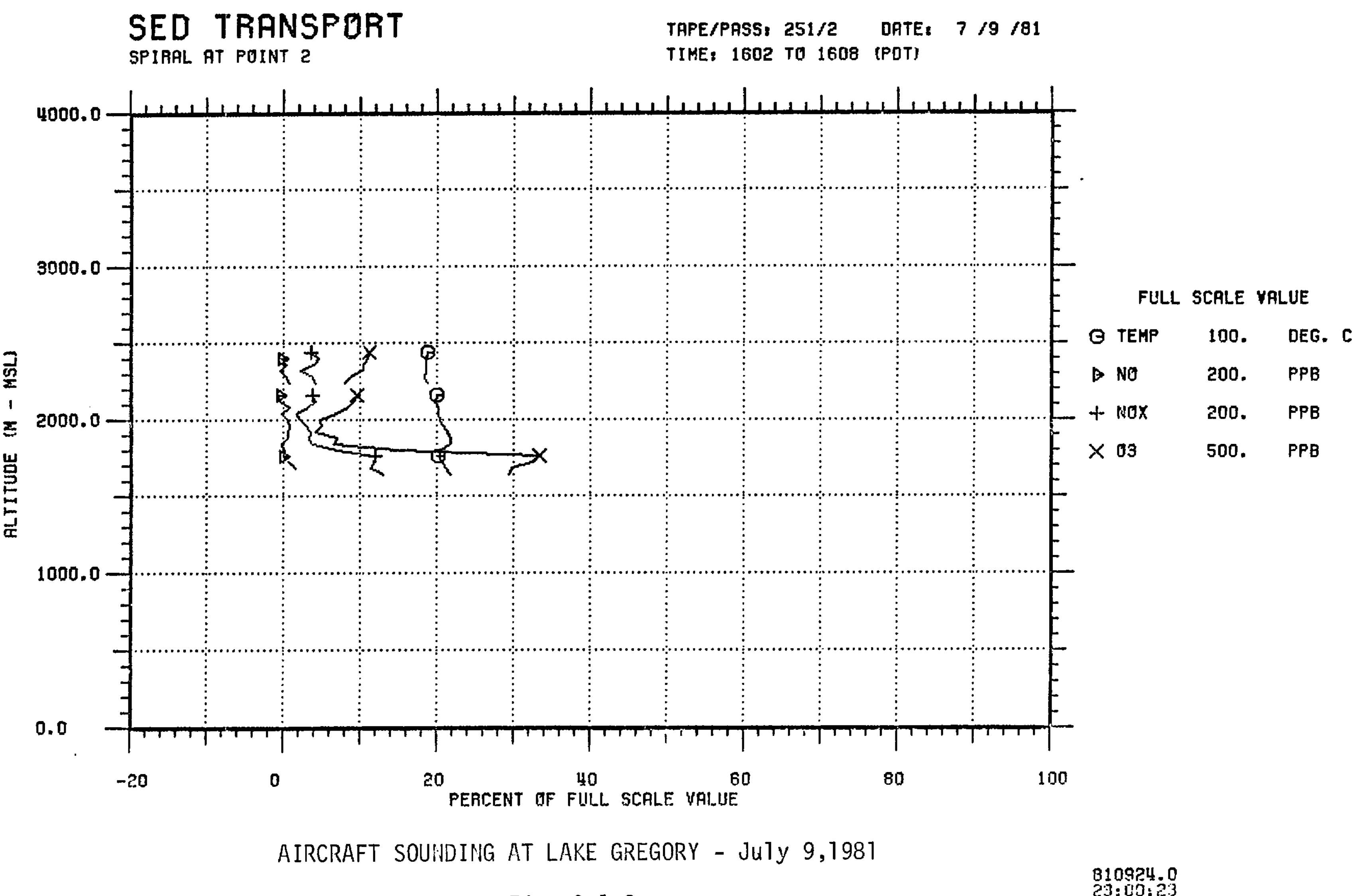
Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start–End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1542	1559	Spiral	1	518-2286	N.A.	A1-13	Sfc Elev = 488 m
2	1602	1608	Spiral	2	2438-1615	N.A.	A14-19	Sfc Elev = 1372 m
3	1615	1636	Spiral	3	945-2743	N.A.	A20-32	Sfc Elev = 915 m
4	1648	1703	Spiral	4	3261-1219	N.A.	A33-45	Sfc Elev = 1204 m Downwind Cajon Pass
5	1713	1729	Spiral	5	1311-3048	N.A.	A49-61	Sfc Elev = 1296 m
6	1730	1737	Zero Spiral		3048-1524	N.A.	0	Instrument calibration
7	1739	1808	Traverse	5 - 6	1524- 945	104.6 Km.	A62-90	Within 350 m of terrain
8	1809	1824	Spiral	6	411-2134	N.A.	A91-101	Sfc Elev = 305 m
9	1843	1851	Spiral	7	3353-1554	N.A.	A102-114	Sfc Elev = 1557 m
10	1854	1901	Spiral	3	914-1829	N.A.	A115-121	Sfc Elev = 915 m

Note: SO_2 monitor INOP



AIRCRAFT SOUNDING AT HIGHLAND - July 9,1981

Fig. 3.1.7



AIRCRAFT SOUNDING AT LAKE GREGORY - July 9,1981

Fig. 3.1.8

with the sounding at Highland the top is shallower (375 m vs. 900 m at Highland). This implies a vertical shrinking of the air column passing over the mountains accompanied by a horizontal stretching (divergence). This conclusion is supported by pibals made at Lake Gregory at the same time which show winds up to 13 m/s from the south-southwest in the pollutant layer.

Figure 3.1.9 shows data from the aircraft spiral east of Hesperia at 1615 PDT. The top of the mixed layer over the desert was about 1400 m (msl). The Hesperia sounding was located almost directly downwind of Lake Gregory and Highland. The lower top of the layer in the desert implies a wave motion over the mountains with a descending component in the lee. The temperatures below 2300 m (msl) are also warmer in the desert than over Lake Gregory in accordance with the lee slope subsidence.

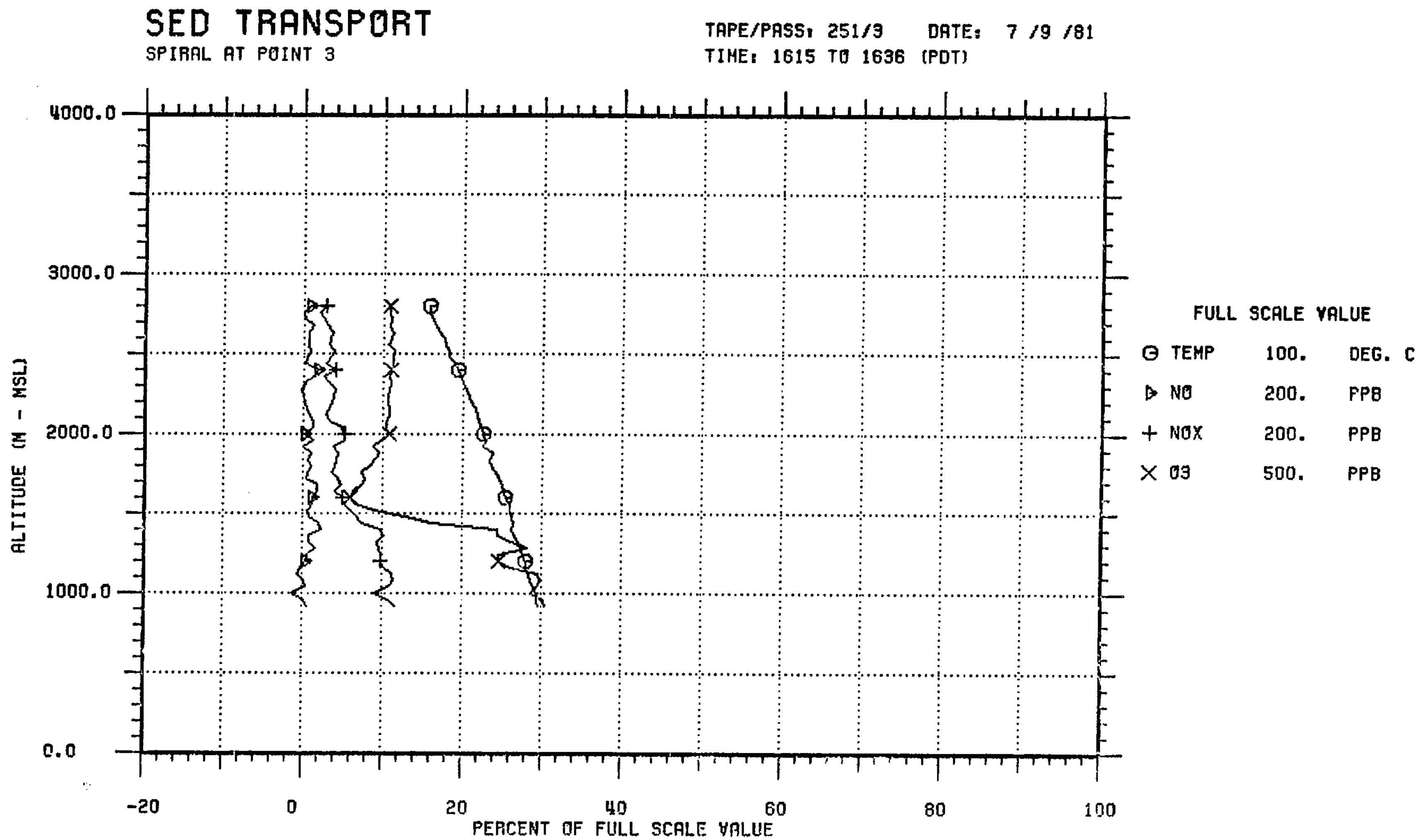
Another spiral was carried out immediately downwind of Cajon Pass at Pt. 4 (Figure 3.1.10). There was a shallow surface layer of ozone observed to a height of about 200 m above ground. A more important layer existed aloft. It is suggested that the upper layer is generated by the action of nearby slopes upwind of the sounding area. Low-level turbulence values confirm that the surface mixed layer was confined to the lowest 200 m. Surface ozone concentrations at 17 PDT were 11 pphm at Cajon Pass and 8 pphm at Victorville. The peak value observed at low levels during the spiral suggests that the spiral was not in the center of the plume passing through Cajon Pass.

Figure 3.1.11 shows a spiral sounding made at a point (5) west of Cajon Pass along Pearblossom Highway. The sounding structure at this location was similar to that observed at Hesperia on the east side of Cajon Pass. The top of the low-level pollutant layer was at about 1800 m (msl).

A traverse was then flown from Pt. 5 through Cajon Pass, San Gorgonio Pass and into the Coachella Valley (Figure 3.1.12). The flight started at about 1500 m (msl) within the low-level ozone layer in the desert. The flight altitude decreased to 1000 m (msl) after passage through Cajon Pass. The ozone concentration at flight level decreased to about 6 pphm at 300-400 m over the terrain through the pass. Thereafter, the ozone increased rapidly reaching a peak of about 26 pphm within and along the north side of San Gorgonio Pass. The hourly surface ozone concentration at Banning was 19 pphm at about the time of the aircraft traverse through the area.

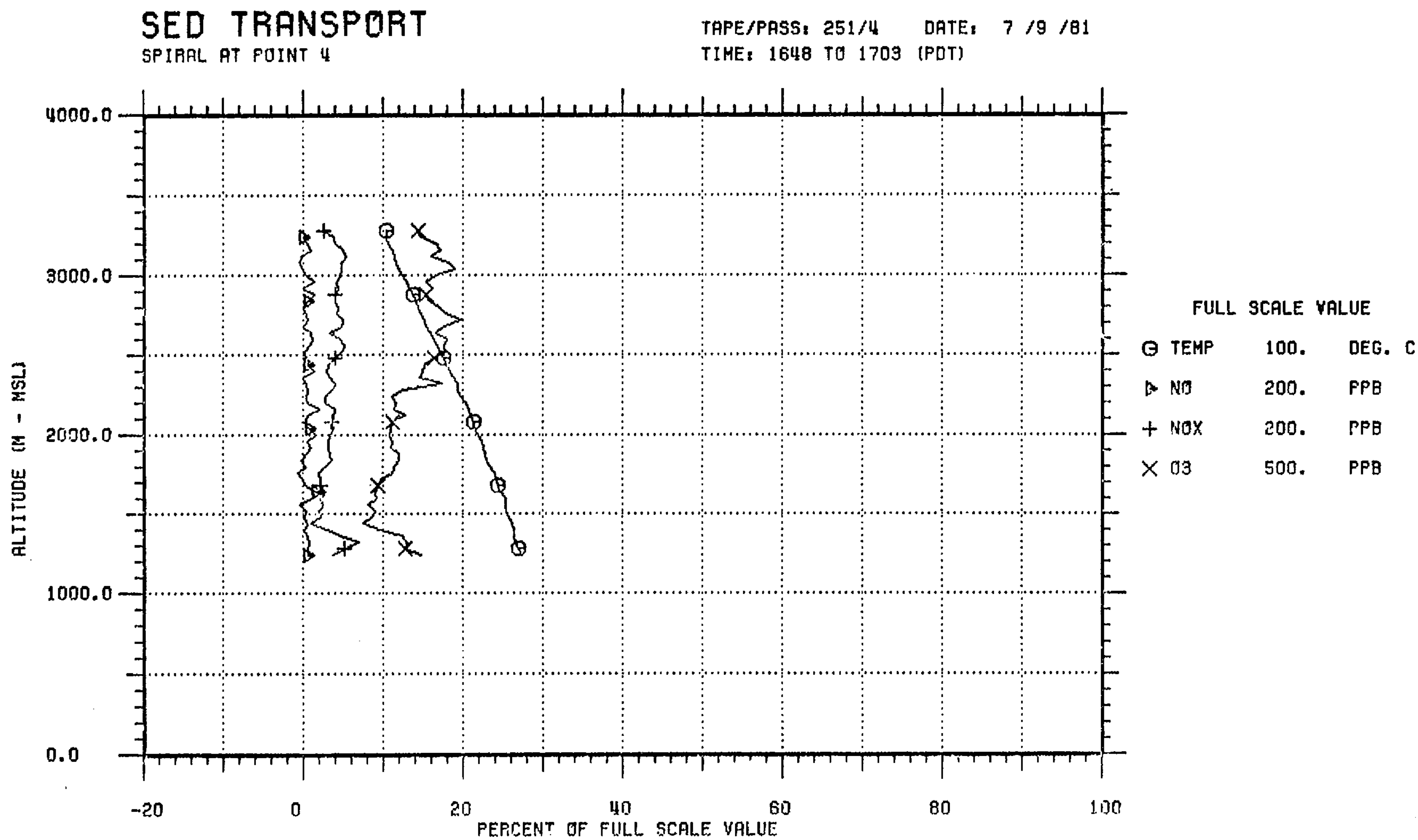
Figure 3.1.13 shows the data from a spiral at 1809 PDT at the intersection of Highways 10 and 111, downwind of San Gorgonio Pass. A mixing layer to 1500 m (msl) is shown with a peak ozone concentration of 21 pphm near the surface. The peak hourly ozone concentration at Palm Springs on July 9 (14 pphm) occurred at 18 PDT at about the same time as the data in Figure 3.1.13 were obtained.

From the desert area the aircraft moved to Lake Arrowhead and carried out a spiral sounding at 1843 PDT (Figure 3.1.14). A large ozone value (15 pphm) was found at the lowest point of the sounding which was near the lake surface. As was the case at Lake Gregory the low-level layer was very shallow (about 200 m thick). Under the wind conditions on July 9, a thin layer of pollution was transported rapidly over the mountains toward the desert.



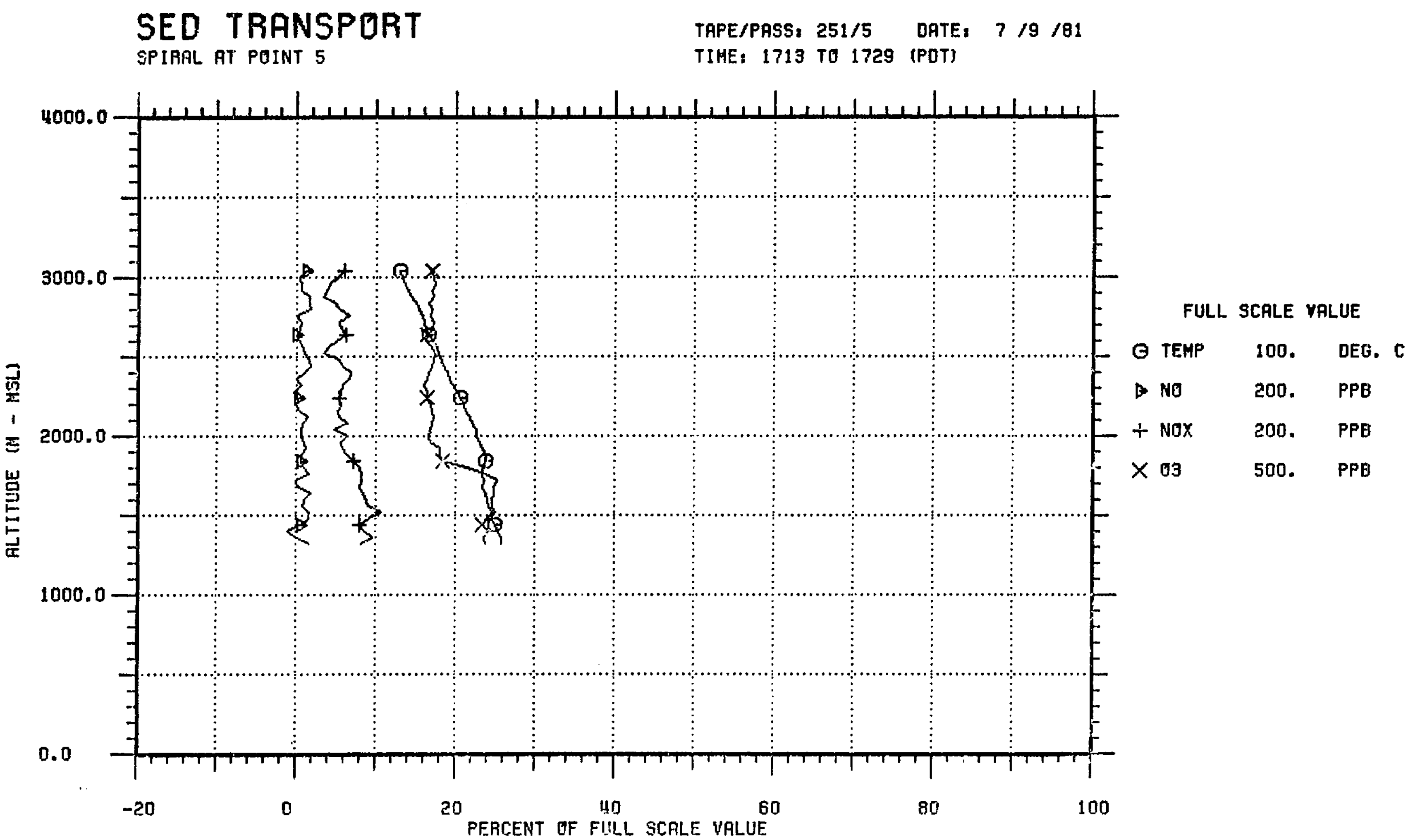
AIRCRAFT SOUNDING EAST OF HESPERIA - July 9,1981

Fig. 3.1.9



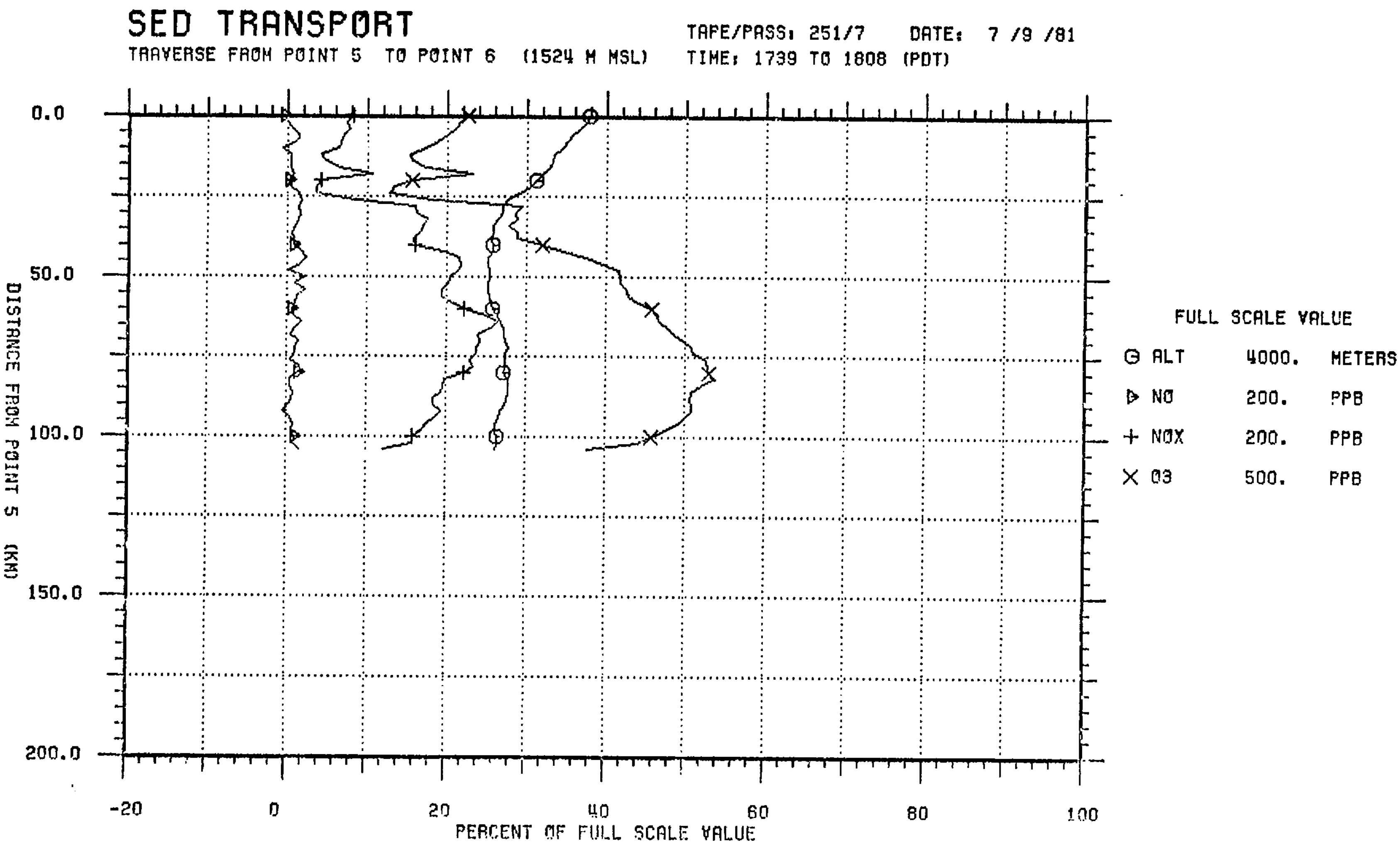
AIRCRAFT SOUNDING AT CAJON PASS - July 9,1981

Fig. 3.1.10



AIRCRAFT SOUNDING NW OF CAJON PASS - July 9,1981

Fig. 3.1.11



AIRCRAFT TRAVERSE FROM NW CAJON PASS TO INTERSECTION I-10/111 - July 9,1981

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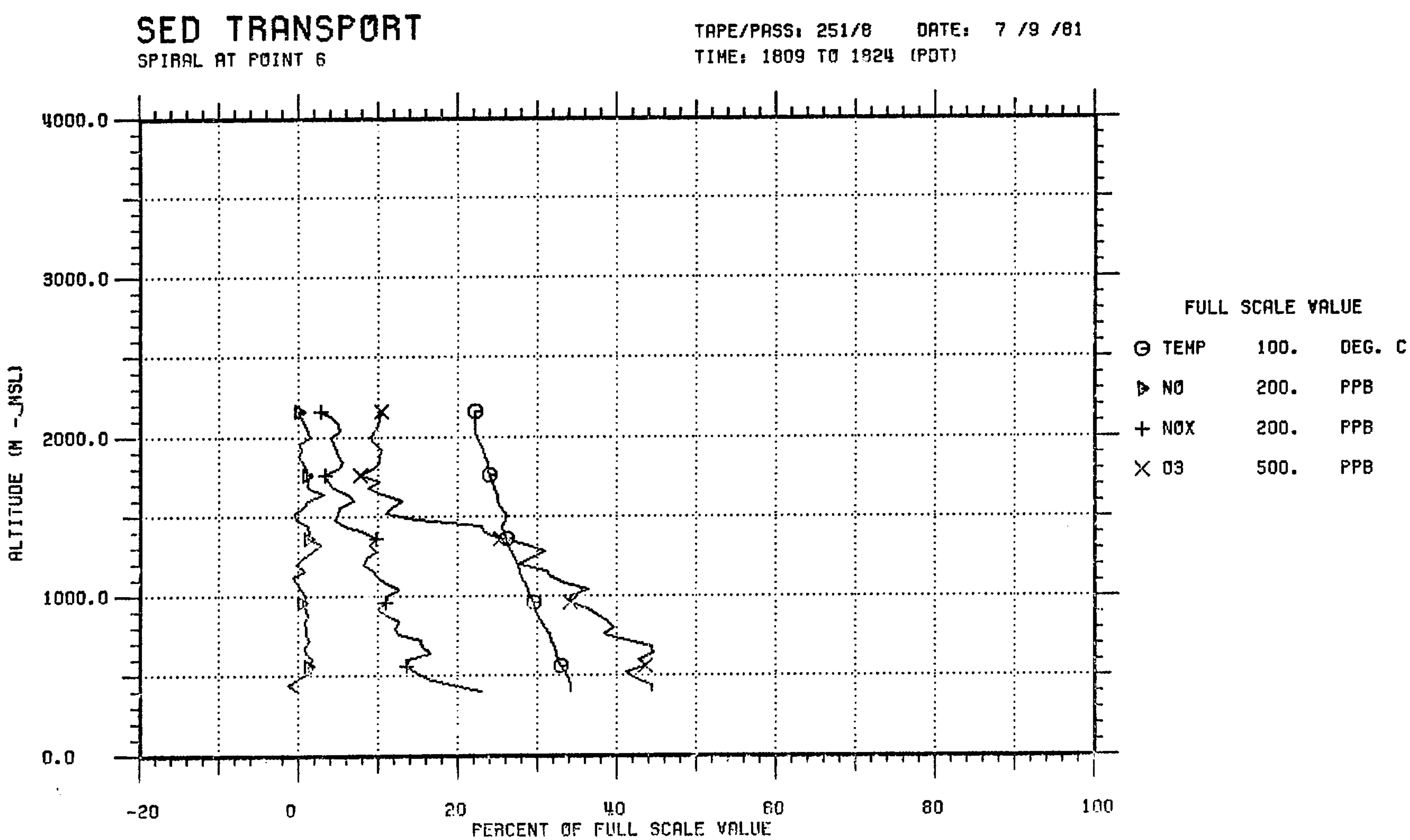
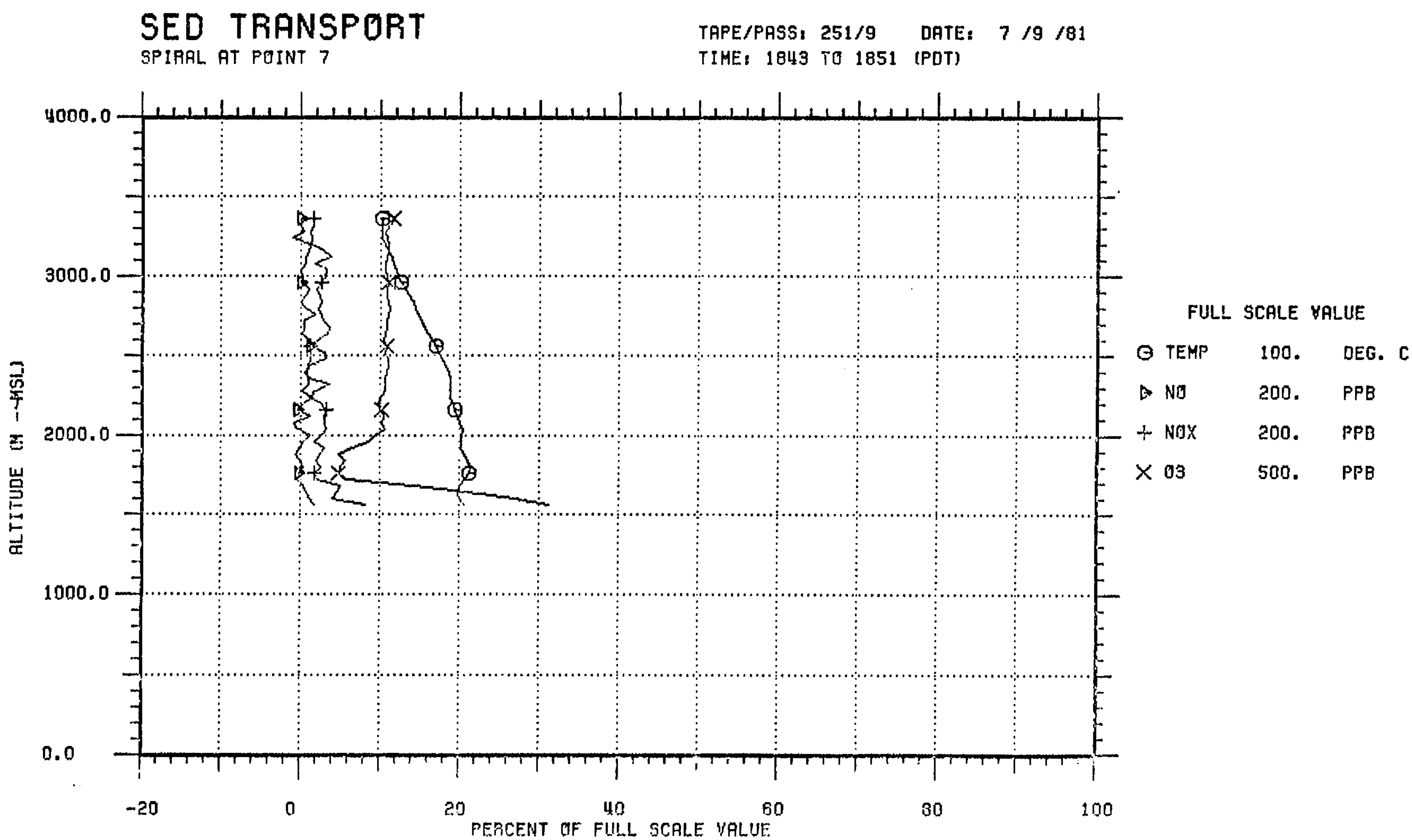
23:42:22

Fig. 3.1.12



AIRCRAFT SOUNDING AT INTERSECTION I-10/111 - July 9,1981

Fig. 3.1.13

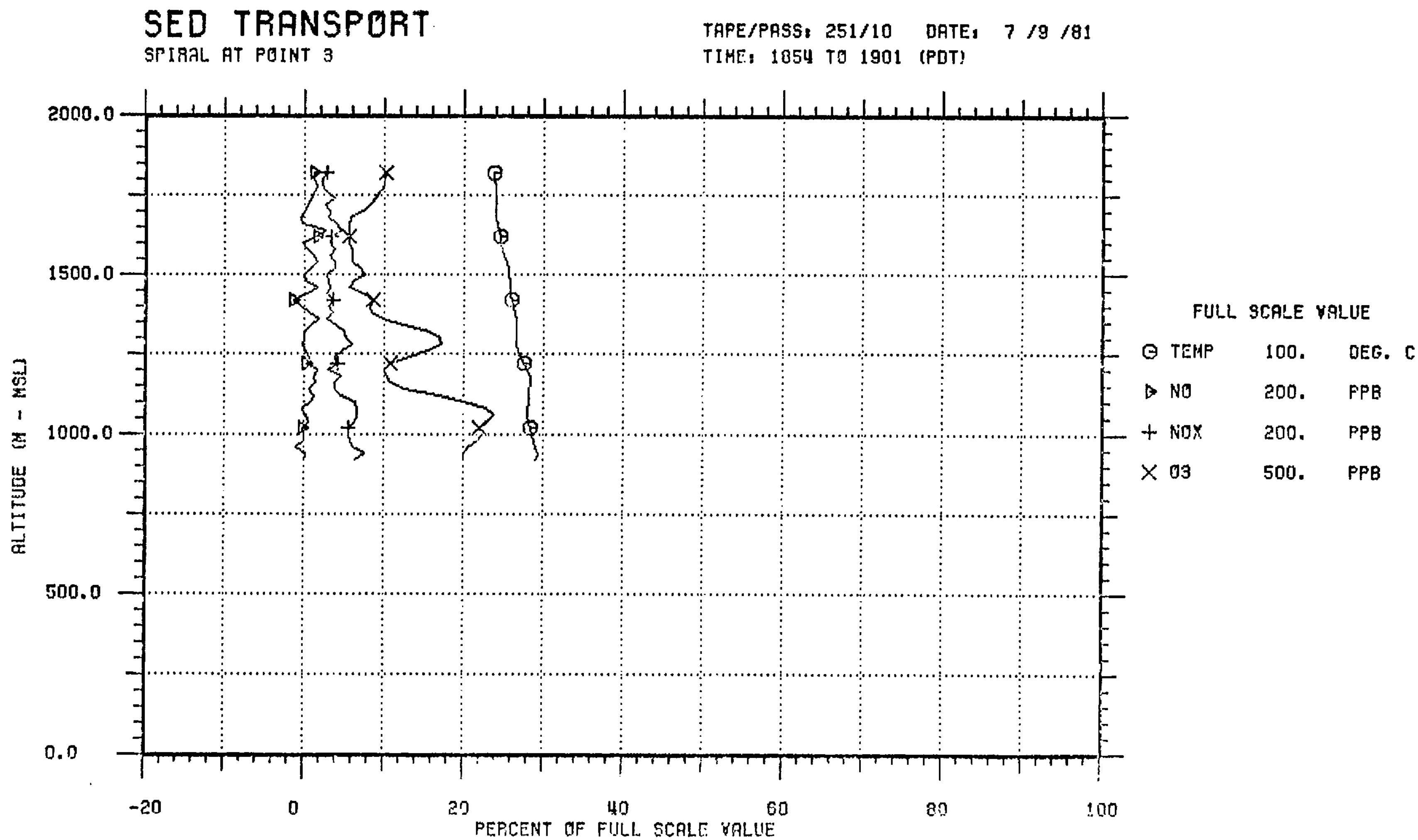


AIRCRAFT SOUNDING AT LAKE ARROWHEAD - July 9,1981

Fig. 3.1.14

810924.0
23:00:23

Figures 3.1.15 and 3.1.16 show a spiral taken at Hesperia at 1854 PDT. This spiral was made at the same location as Figure 3.1.9 which was carried out at 1615 PDT. The low-level ozone layer extending to 1400 m (msl) is still apparent in the later sounding. Figure 3.1.16 shows additional parameters for the same sounding. The low-level mixed layer to 1400 m (msl) is clearly delineated by the turbulence profile. It is also of interest to note that this layer is drier than the layer aloft in keeping with the hypothesis of downslope flow in the lee of the mountains.



AIRCRAFT SOUNDING EAST OF HESPERIA - July 9,1981

Fig. 3.1.15

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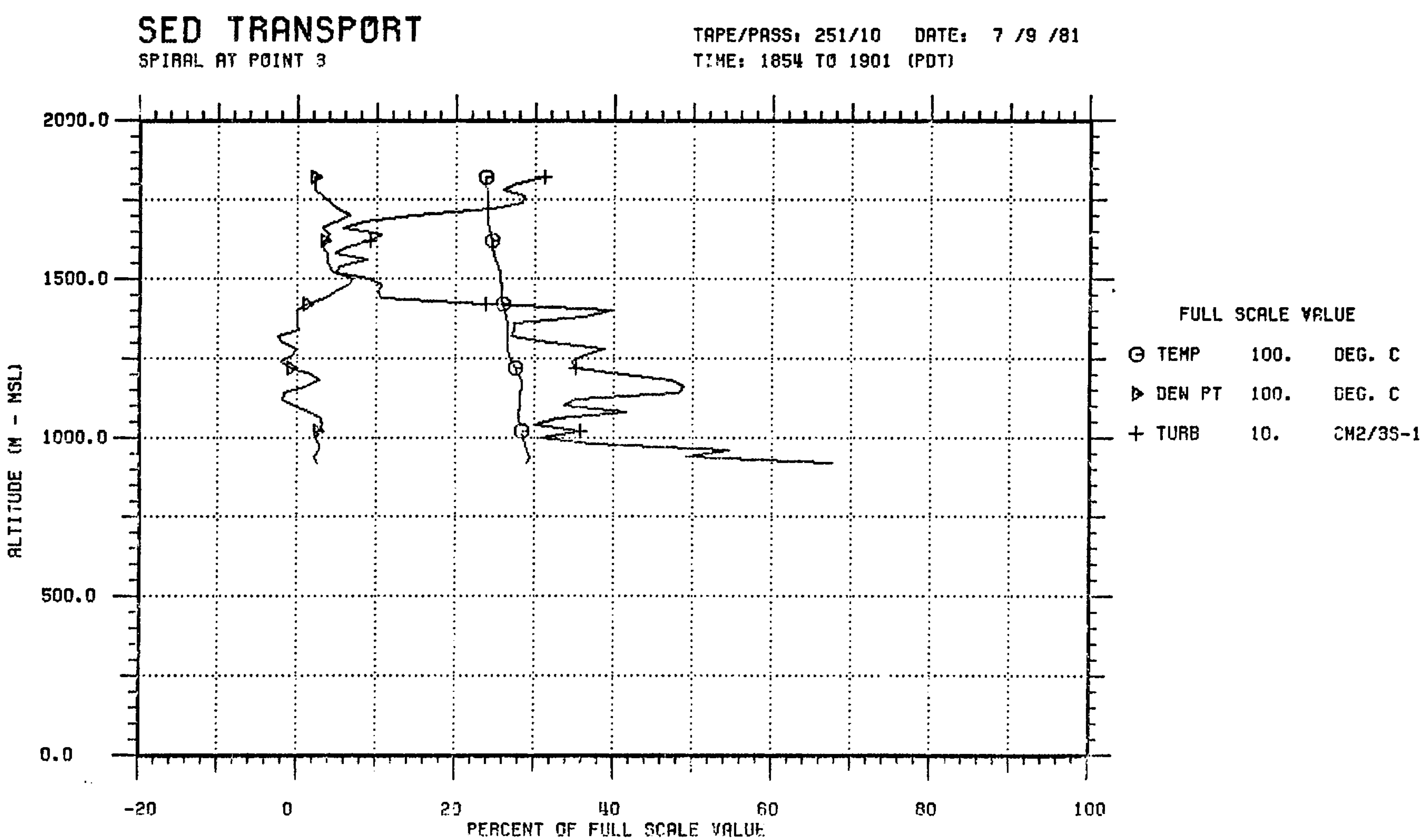


AIRCRAFT SOUNDING EAST OF HESPERIA - July 9,1981

Fig. 3.1.16

3.1.4 Tracer Results - Test 1

Release Location: Culver City
Date: July 9, 1981
Time: 0600-1000 PDT
Release Rate: 13.0 g/sec. SF_6

Surface winds at Culver City during the tracer release were from the southwest. Velocities were light, increasing slightly by the end of the release. Figs. 3.1.17 and 3.1.18 give the streamline wind patterns for 10 PDT and 16 PDT on July 9. By 10 PDT the flows through all of the passes were already established. These flows continued and increased somewhat by 16 PDT in response to the average pressure gradients which existed between the coast and the inland areas. In the western part of the Los Angeles basin the indicated wind flow was from the south to southwest at 10 PDT, shifting to a more westerly direction by 16 PDT.

July 9

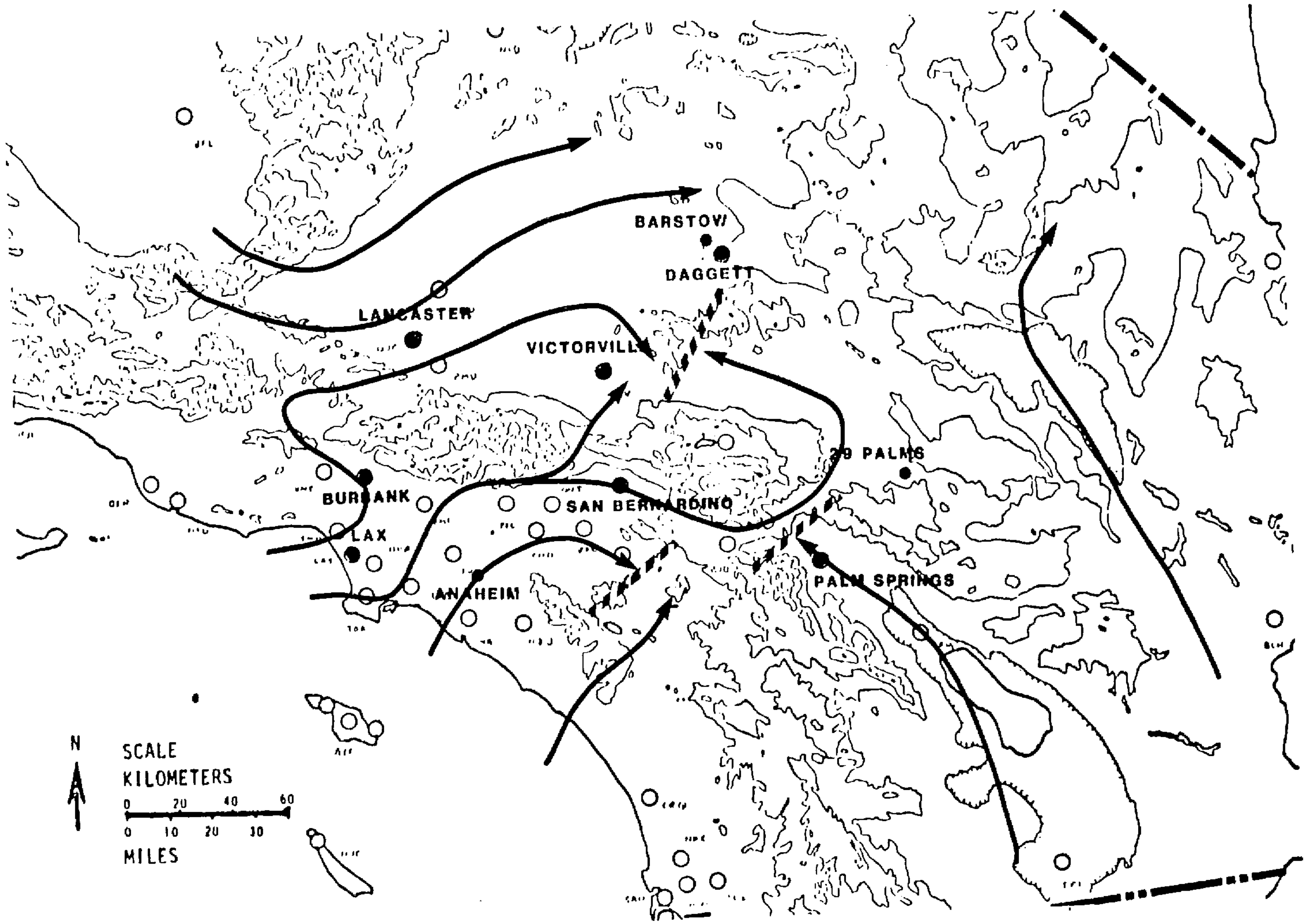
Estimated plume trajectories for July 9 are shown in Fig. 3.1.19. The primary tracer plume trajectory was directed to the north-northeast through the eastern part of the San Fernando Valley. As a result of the low wind speeds during the release periods initial concentrations in the release area were quite large and a strong tracer impact was observed as far away as San Fernando and Sunland (over 200 ppt at 33 km downwind).

The main tracer plume continued past Newhall, through Soledad Canyon, reaching Barstow by 18 PDT (26 ppt as measured by an aircraft sample). Travel time to Barstow corresponded to an average velocity of about 6 m/s.

The later part of the tracer release was affected by the westerly shift in wind direction and with the plume being carried eastward through Azusa and San Bernardino into the Coachella Valley as far south as Bombay Beach on the eastern shore of Salton Sea. Small tracer concetrations were also observed at Lake Arrowhead and Riverside.

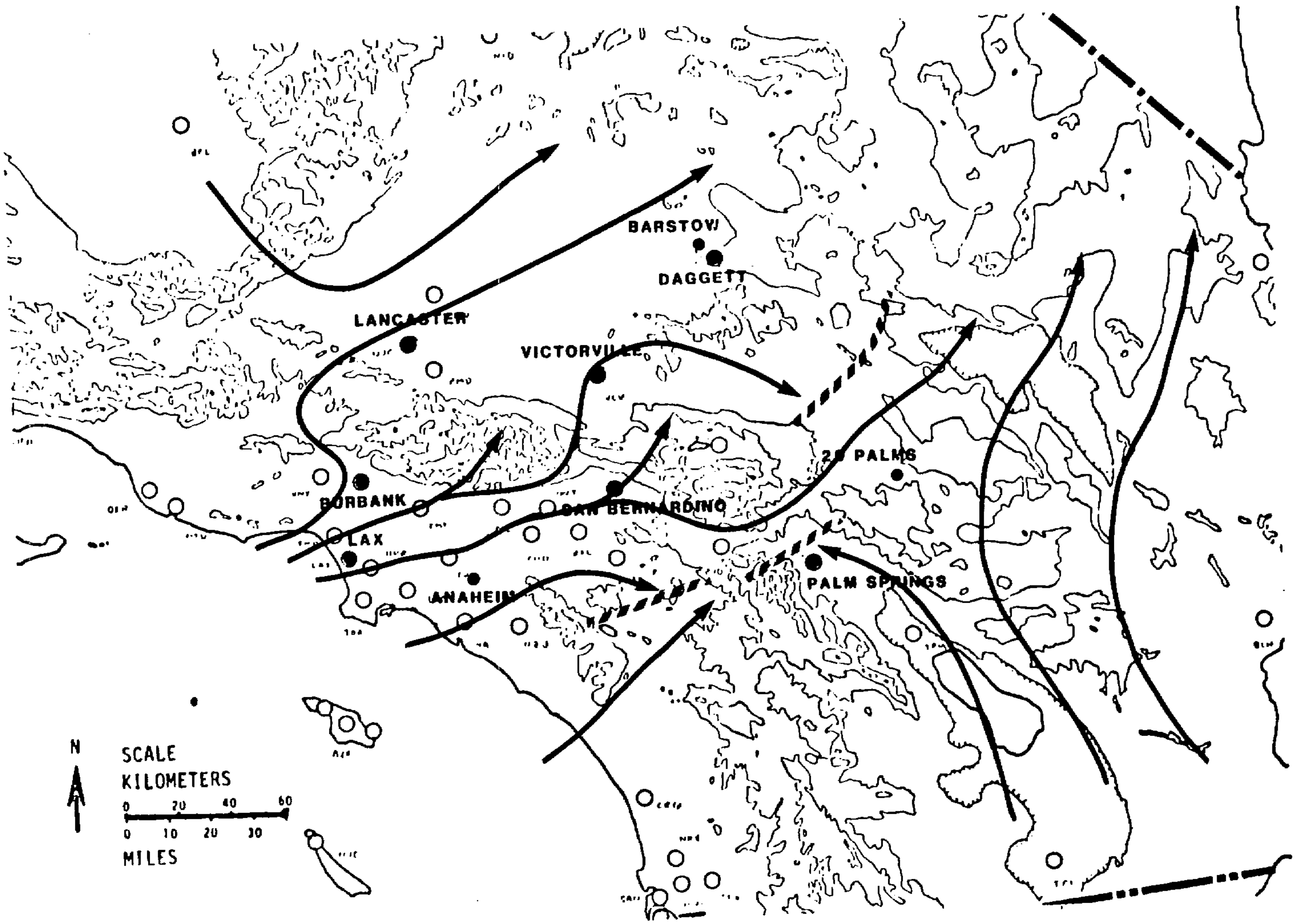
A plot of the Xu/Q values for the July 9 release is shown in Fig. 3.1.20. The calculated values are based on the maximum concentrations observed by hourly samplers, mobile traverses or aircraft samples. The wind speed used in the calculation was the average wind speed observed at the release site during the release period. This wind was measured at about 6 feet above ground level and should provide a reasonable estimate of the initial dilution of the tracer plume.

The Xu/Q values in Fig. 3.1.20 generally correspond to C-D stability conditions as estimated by a Gaussian diffusion model. The model comparison values correspond to centerline concentrations. The observed concentrations may not have been obtained on the centerline and some of the Xu/Q values shown may be reduced as a result.



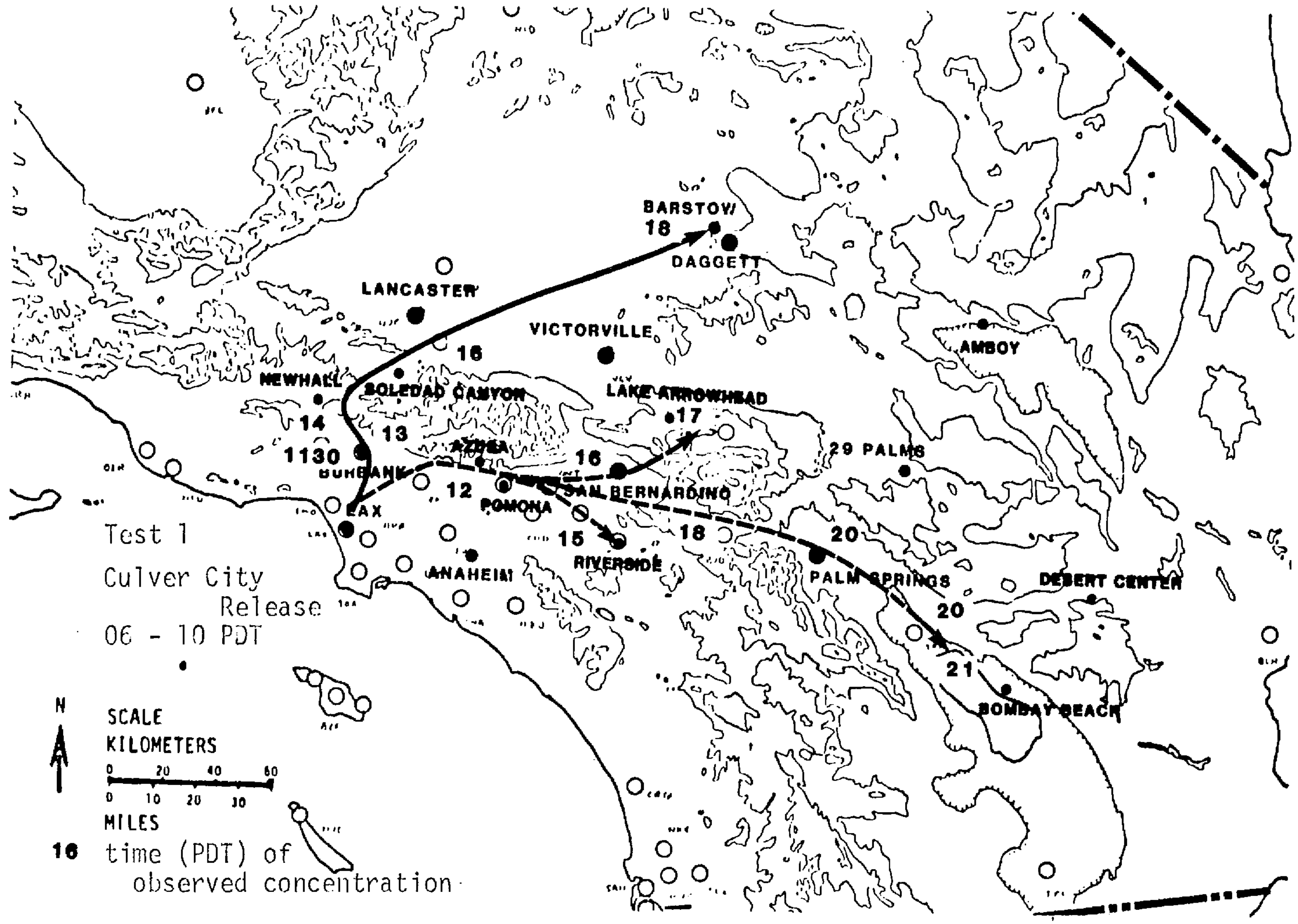
STREAMLINE MAP (10 PDT) - July 9,1981

Fig. 3.1.17



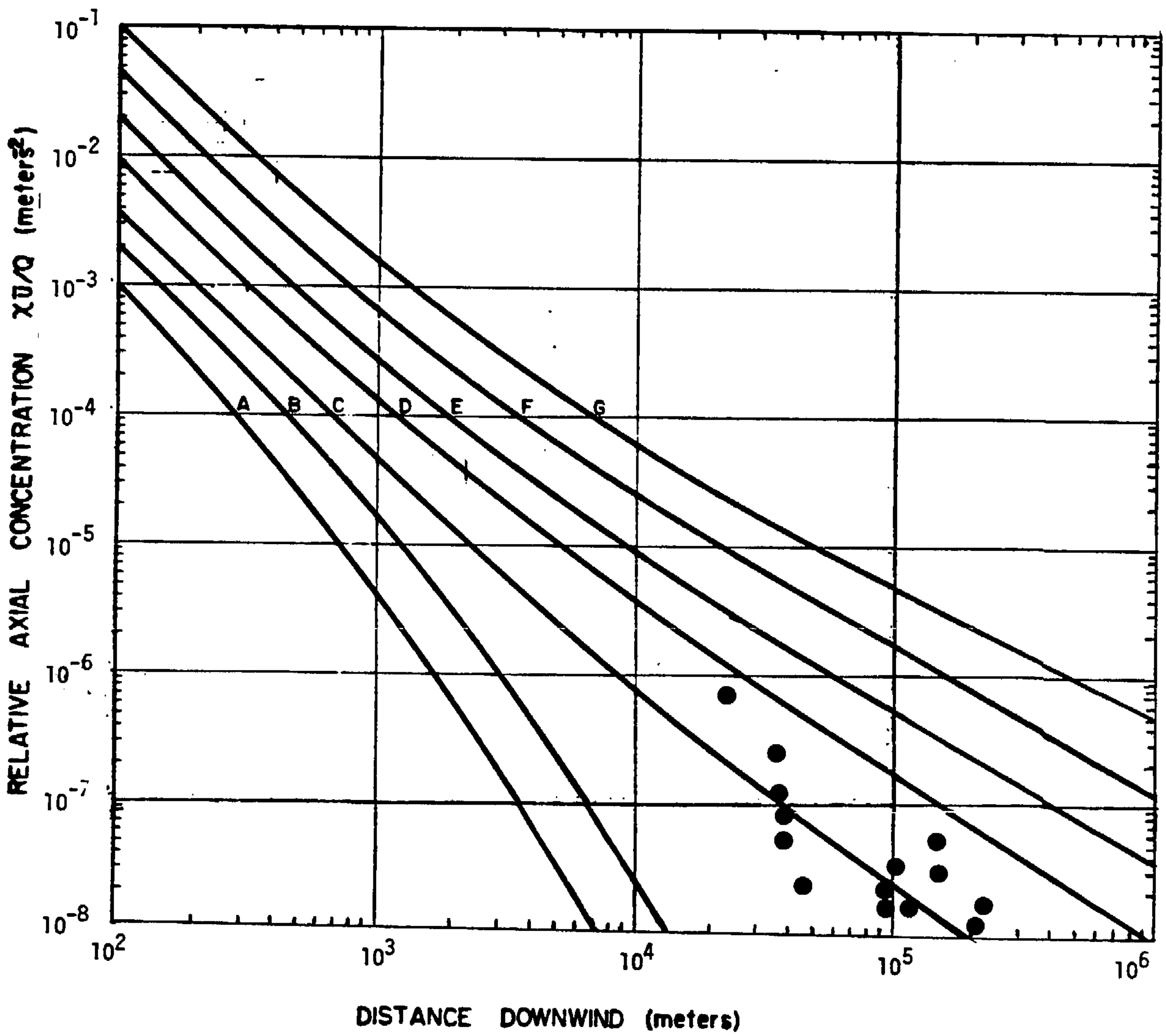
STREAMLINE MAP (16 PDT) - July 9,1981

Fig. 3.1.18



TRACER TRAJECTORIES - July 9,1981

Fig. 3.1.19



CALCULATED XU/Q VALUES - Test 1

July 9,1981

Fig. 3.1.20

July 10

An extensive set of automobile traverses was conducted on July 10 to explore the possibility of carry-over from the previous day's tracer release. Traverses were carried out from Barstow to Amboy, Barstow to Lancaster, Amboy to Desert Center and 29 Palms to Desert Center. No significant concentrations were observed in the desert areas on July 10.

During the course of the automobile sampling the area from Pasadena eastward to Upland and San Bernardino was sampled a number of times. At 09 PDT a traverse started at Pasadena and ended at Barstow without observing significant tracer concentrations. By 14 PDT and continuing until 20 PDT tracer concentrations were observed to the east of Pasadena as far east as Pomona and Upland. A peak concentration of 127 ppt was observed at about 17 PDT near the intersection of Highways 605 and 210. Numerous sample concentrations over 20 ppt were found during the six hour period by a number of different traverse teams. Most of the significant sample peaks were located in the area from this intersection to the vicinity of Pomona although concentrations over 60 ppt were observed as far south as Highway 10 near or slightly west of its intersection with Highway 605. Hourly samples at Pasadena did not show any significant concentrations on July 10. Hourly concentrations at Azusa showed 24 and 14 ppt at 08 and 09 PDT, respectively, on July 10.

The occurrence of these SF_6 concentrations in the Los Angeles basin on the following day is discussed further in Section 4.7.

3.2 Test 2 14-15 July 1981, Sylmar Release (1100-1500 PDT, 7/14/81)

3.2.1 Meteorology

General

A low pressure center aloft (Figure 3.2.1) passed across the coast of Washington-Oregon on July 13, moving into southern Alberta on July 14. Pressures aloft rose over southwestern U.S. and the Southern California area was dominated on July 14 by a stagnant high pressure aloft and a substantial high pressure ridge extending from the Pacific Ocean into Washington, Oregon and northern California.

As shown in Table 3.2.1, the 850 mb temperature at Vandenberg AFB was slightly warmer than the July average of 20°C. The pressure gradients to Bakersfield and Daggett were quite low, LAX-Bakersfield showing a negative gradient at 08 PDT (Bakersfield pressure higher than Los Angeles airport). The inversion base at UCLA was observed to be at the surface with a relatively low inversion top height. The maximum surface temperature at Ontario was a rather warm 101°F.

Meteorological conditions on July 14 indicated relatively stagnant wind patterns with warm temperatures and low inversion heights.

Transport Winds

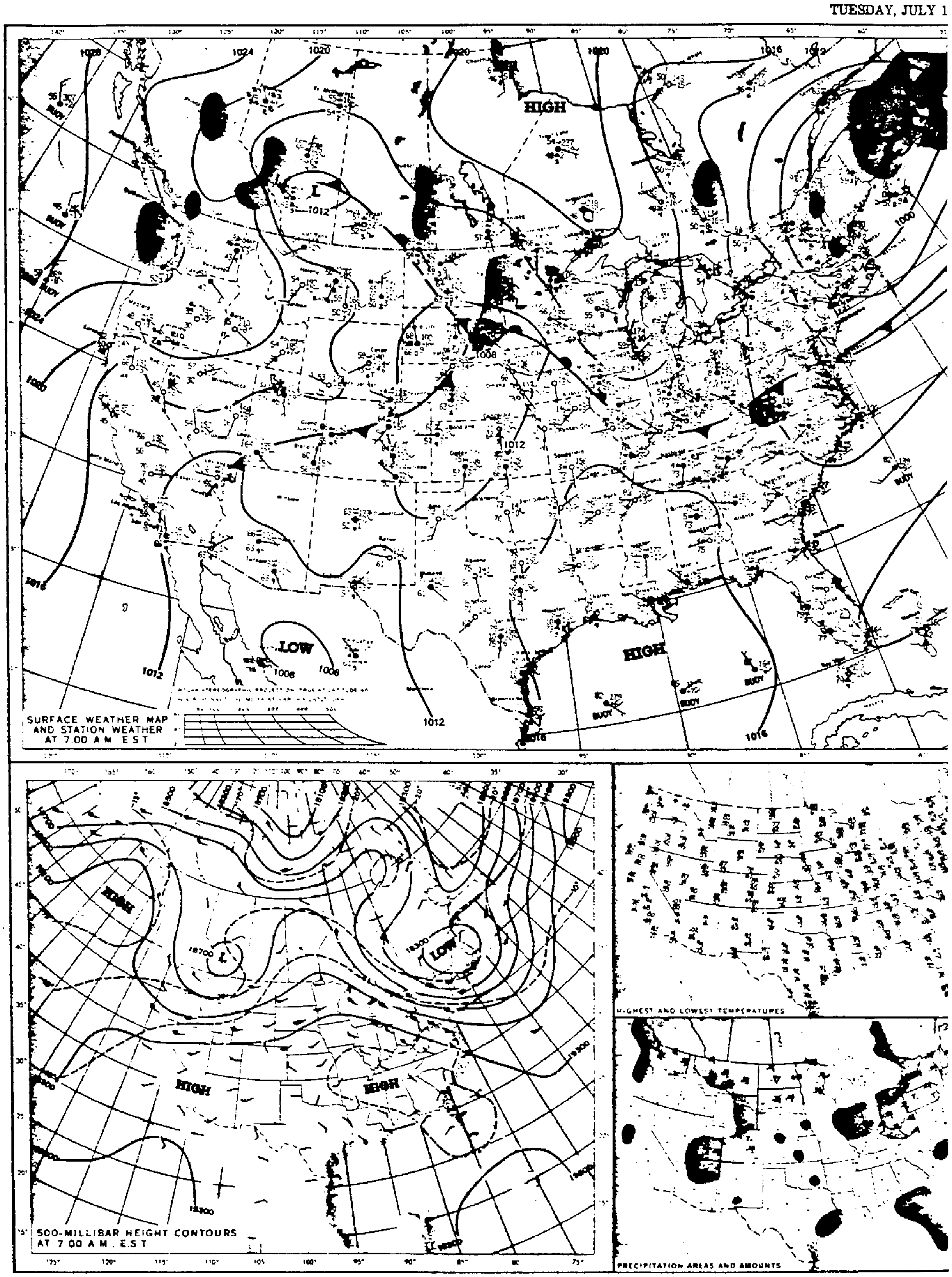
Surface winds at Sylmar during the tracer release are shown in Table 3.2.2:

Table 3.2.2

SURFACE WINDS AT SYLMAR DURING RELEASE

JULY 14, 1981

Time (PDT)	Direction (°)	Speed (m/s)
10	220	1.3
11	210	1.7
12	220	1.4
13	210	1.7
14	200	2.1
15	180	3.0



WEATHER MAP

July 14,1981

Fig. 3.2.1

Table 3.2.1

METEOROLOGICAL PARAMETERS

JULY 14, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	22.0°C
Edwards AFB	(0630 PDT)	25.8
Ontario	(0830 PDT)	23.9
UCLA	(0600 PDT)	23.4
Pressure Gradients	(0800 PDT)	
LAX - Daggett		1.1 mb
LAX - Bakersfield		-0.2
Maximum Surface Temperature		
Ontario		101°F (38.3°C)
Palm Springs		106 (41.1)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	17.5°C (surface)
Rialto	(0700 PDT)	20.0 (Surface)
Ontario	(0830 PDT)	22.4 (550 m)
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	26.0°C (967 m)
Rialto	(0700 PDT)	26.7 (895 m)
Ontario	(0830 PDT)	26.4 (980 m)

* All heights are msl

The surface winds at Sylmar indicate that a light southerly sea breeze flow had commmenced by the beginning of the release period. As is customary, the wind velocities increased considerably by early to mid-afternoon. The direction of the flow was such as to carry the tracer material out of the basin through Newhall and Soledad/Mint Canyon.

Table 3.2.3 gives the surface wind observations at Lancaster, Victorville and Palm Springs on July 14-15. At Lancaster, the weak pressure gradients on July 14 are reflected in light, variable winds except for the period 14 PDT to 24 PDT when the flow through Mint Canyon was present. Slightly increased gradients on July 15 resulted in somewhat stronger wind velocities in the afternoon at Lancaster.

At Victorville, southerly winds on July 14 existed for only a brief period (14-20 PDT). On July 15 the stronger pressure gradients resulted in a much more extended period of southerly flow.

At Palm Springs, there was no evidence of early evening flow from San Gorgonio Pass on either July 14 or 15. Northwesterly winds during the day on July 15 were apparently associated with rain showers in the area.

Mixing Heights

Observed and predicted maximum mixing heights for July 14 are shown in Table 3.2.4. A shallow mixing layer was observed along the coast at UCLA. Inland the mixed layer was found to be considerably deeper (900 m at Upland at 1535 PDT). The mixing heights observed at Acton, southwest of Palmdale and Adelanto were all relatively high, even compared to the maximum predicted for Edwards AFB. These heights suggest that, under the conditions existing on July 14, convergent flow through the Newhall-Mint Canyon route may result in mixed layer depths substantially higher than experienced in other nearby areas. It should be noted that the temperatures aloft were above average and the existing inversion was relatively strong (see Table 3.2.1).

Visibilities reported at San Bernardino and Ontario are shown in Table 3.2.5. Visibilities were generally restricted at Ontario throughout the day. At San Bernardino, however, there was a sharp increase in visibility near noon but a marked decrease during the afternoon as additional pollutants were advected from the west.

Table 3.2.5

OBSERVED VISIBILITIES - JULY 14, 1981

Time (PDT)	San Bernardino	Ontario
10	8 miles	4 miles
12	20	4
14	10	9
16	10	5
18	4	6

Table 3.2.3

SURFACE WINDS - JULY 14-15, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	320°/ 2.5 m/s	140°/2.6 m/s	-
08	Calm	140 /2.6	280°/2.1 m/s
10	310 / 2.1	Calm	130 /3.1
12	Calm	080 /2.1	080 /4.1
14	290 / 3.6	Calm	130 /5.1
16	260 / 7.2	190 /5.1	070 /5.7
18	240 /10.3	210 /5.1	060 /5.7
20	280 / 7.2	230 /2.1	060 /2.6
22	270 / 7.7	Calm	250 /1.5
24	250 / 4.6	280 /2.1	-
02	Calm	140 /1.0	-
04	Calm	160 /1.0	-
06	Calm	210 /2.1	-
08	Calm	150 /5.1	290 /7.2
10	Calm	200 /6.2	300 /6.2
12	230 / 9.3	160 /4.6	300 /3.6
14	240 /11.3	150 /6.2	260 /3.6
16	240 / 8.8	190 /4.6	270 /5.1
18	240 /10.3	210 /3.1	260 /2.6

Table 3.2.4

MIXING HEIGHTS - JULY 14, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	Surface	150 m
	1200	397 m	150
Ontario	0830	390	290
	1430	1020	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Upland	1535 PDT	900 m	450 m
Acton	1627	3000 +	800
5 mi. W Palmdale	1740	2200	700
Adelanto AP	1903	2000 +	900

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	2170 m	290 m
San Bernardino	1580	360
Edwards AFB	1525	725

3.2.2 Regional Pollutant Levels

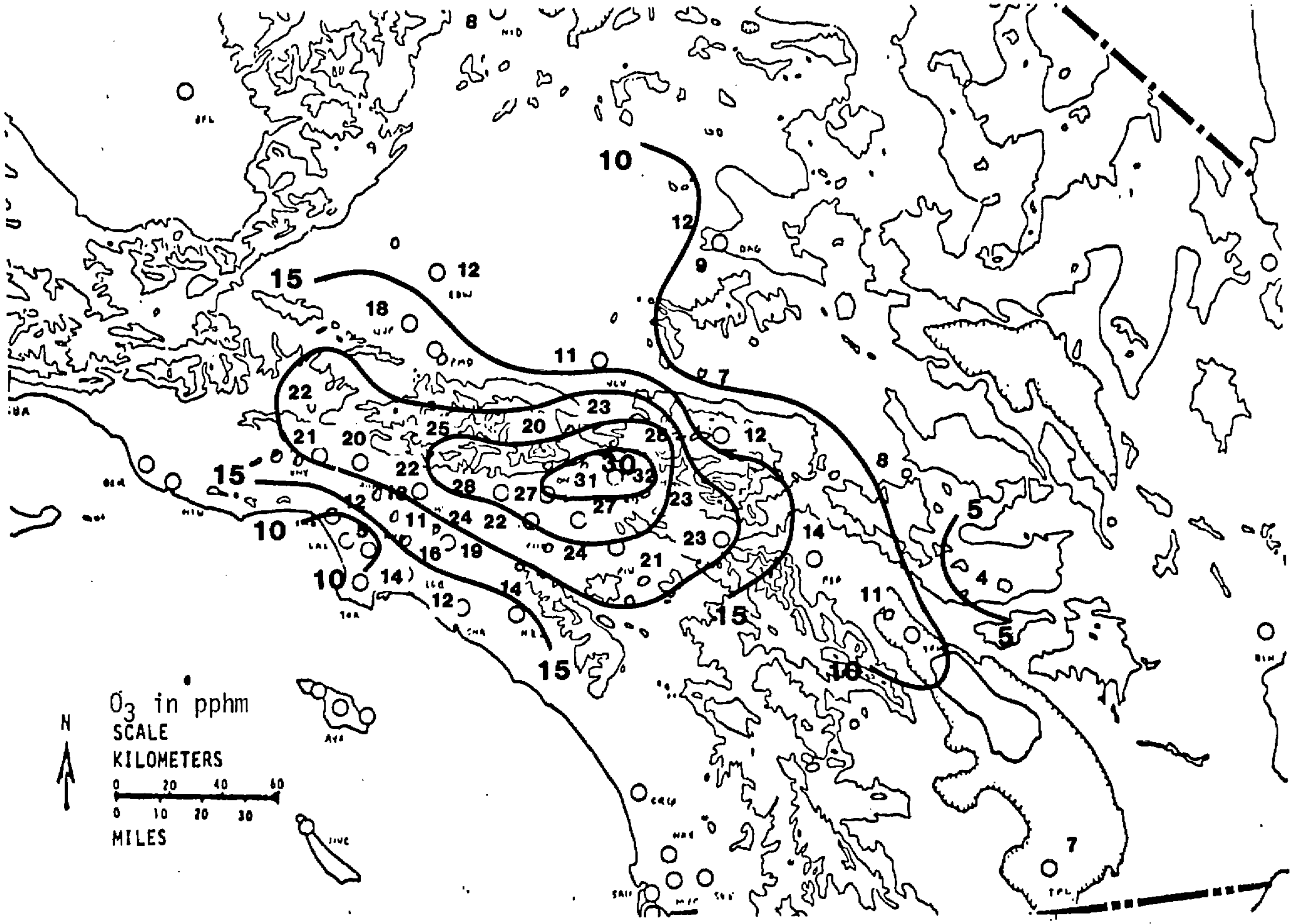
A map of the peak hourly ozone concentrations on July 14 for the Los Angeles basin and the desert areas is shown in Figure 3.2.2. Highest concentrations observed were at San Bernardino (32 pphm) and Fontana (31 pphm). Lake Gregory had the highest concentration recorded in the mountain areas (28 pphm). The desert areas close to the basin experienced a number of exceedances of the state ozone standard. Lancaster had a maximum hourly concentration of 18 pphm.

Figure 3.2.3 shows the timing of the peak hourly ozone concentrations within the basin and desert areas. All desert areas with the exception of Desert Center and El Centro show the late afternoon or evening ozone peaks which are indicative of transport from the basin into the desert. Both Banning and Cajon Pass show evening peaks which are later than might be expected from the nearby stations. This discrepancy is shown more clearly in Figures 3.2.4 and 3.2.5 where hourly ozone concentrations along several of the transport routes into the desert are shown. In Figure 3.2.4 the peak concentration at Banning clearly does not fit between Riverside and Palm Springs/Indio. The implication drawn from the data is that the ozone maximum was transported into the Coachella Valley without being apparent at the surface at Banning. As noted later, there are indications that the material was present aloft over San Gorgonio Pass and then surfaced in the Palm Springs area.

The peak concentrations in the mountain areas (Figure 3.2.4) occur at slightly later times from Mt. Baldy eastward with the exception of an early peak at Mt. Baldy. This must result from carry-over pollutants in the eastern part of the basin being transported upslope during the forenoon. A minor but definitive ozone peak was observed at Fawnskin, at a time corresponding to transport from the basin.

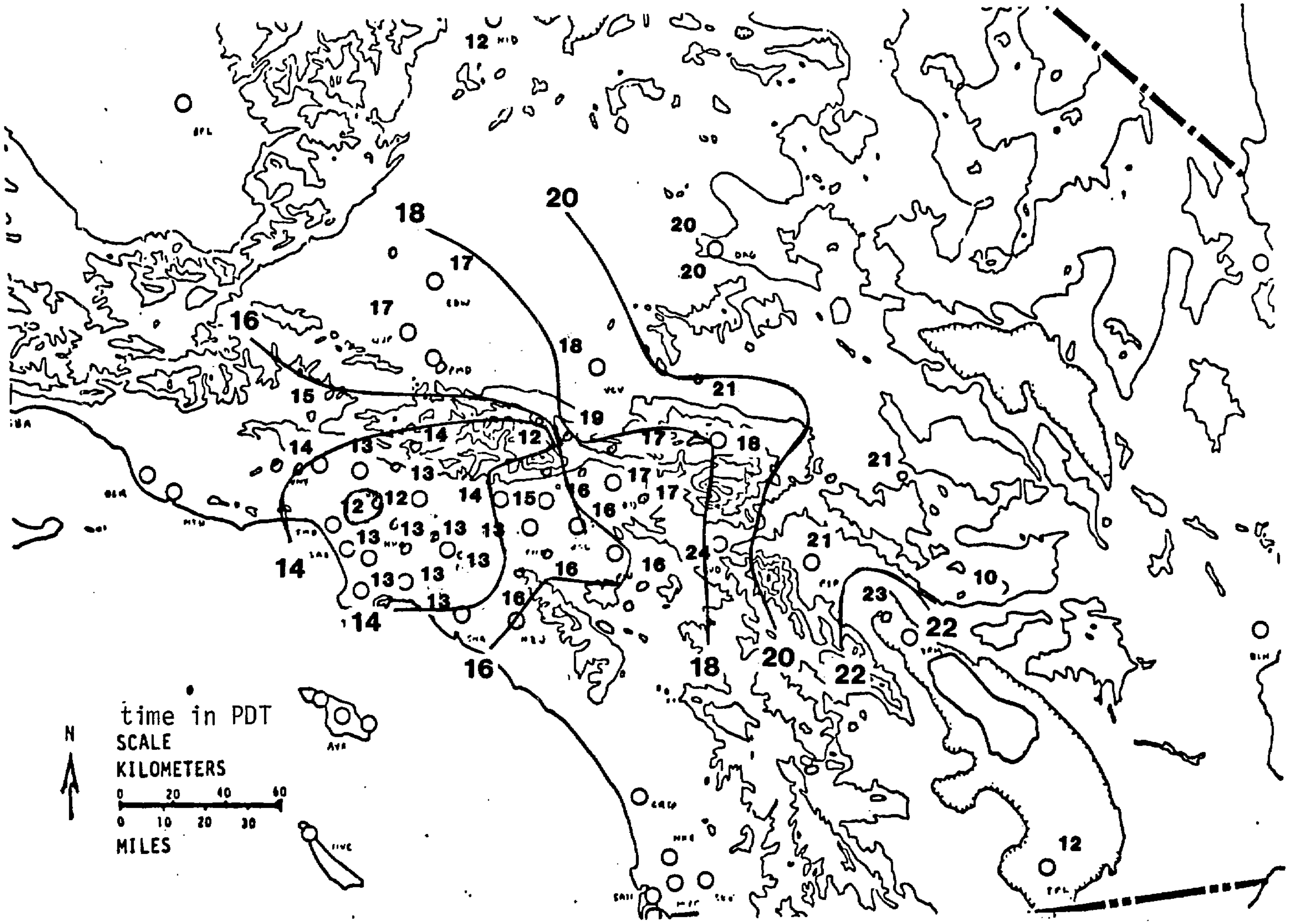
Figure 3.2.5 shows the hourly concentrations along the routes through Cajon Pass and Mint Canyon. The sequence from San Bernardino to Barstow shows a steady progression of peak ozone concentrations but with some complexity at Cajon Pass. There is an early peak (14 PDT) and the peak indicated at San Bernardino and Lake Gregory lasts for a much longer period of time at Cajon.

The tranport route through Mint Canyon is indicated in Figure 3.2.5 by the successively later peaks from Newhall to Edwards AFB. It is not clear from these data whether Barstow received its late evening peak concentrations from the Edwards or the Victorville route. Surface winds at Barstow during the late afternoon and evening were primarily from the west, suggesting the Mint Canyon route as perhaps the more reasonable one.



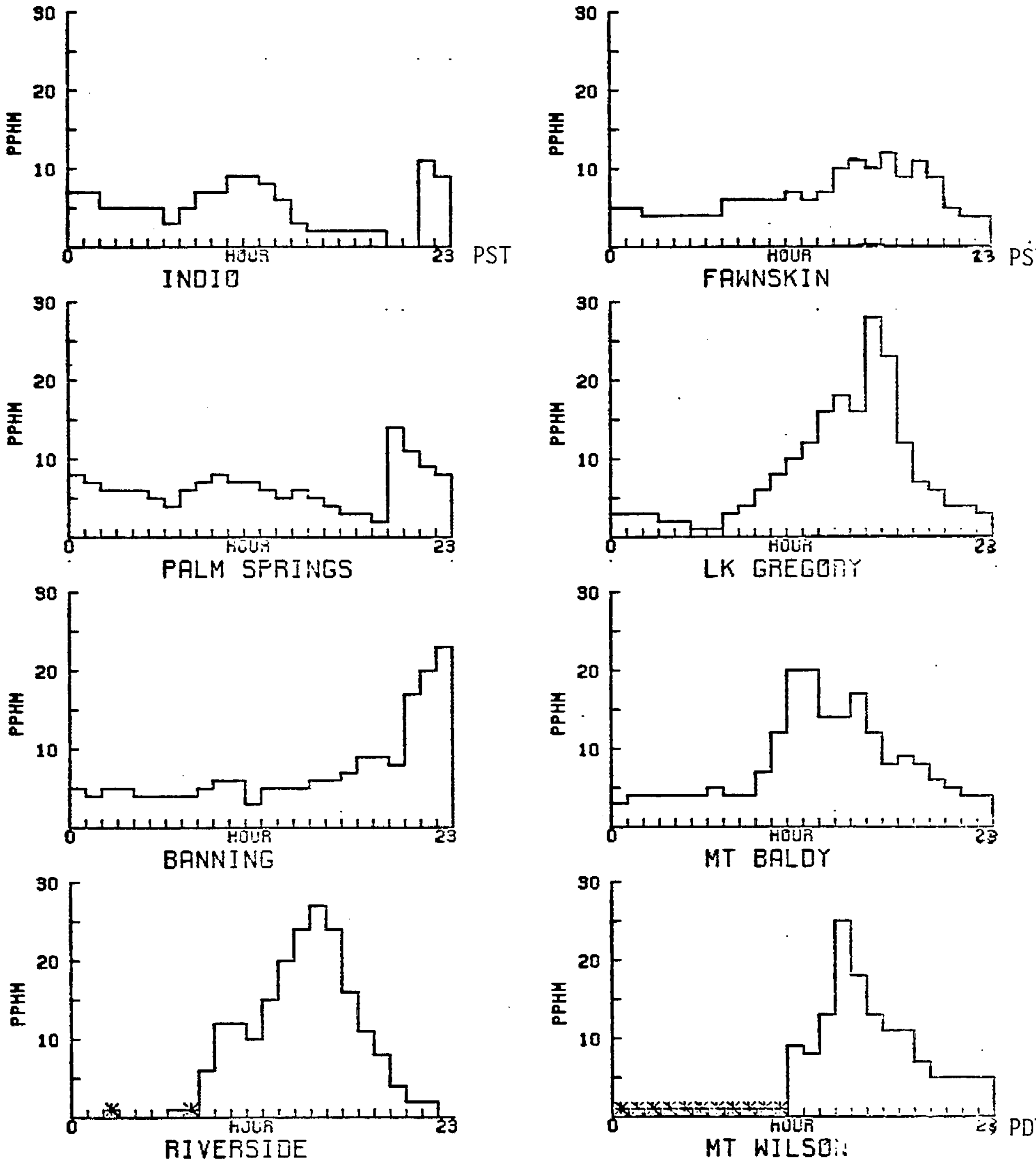
MAXIMUM HOURLY OZONE CONCENTRATIONS - July 14,1981

Fig. 3.2.2



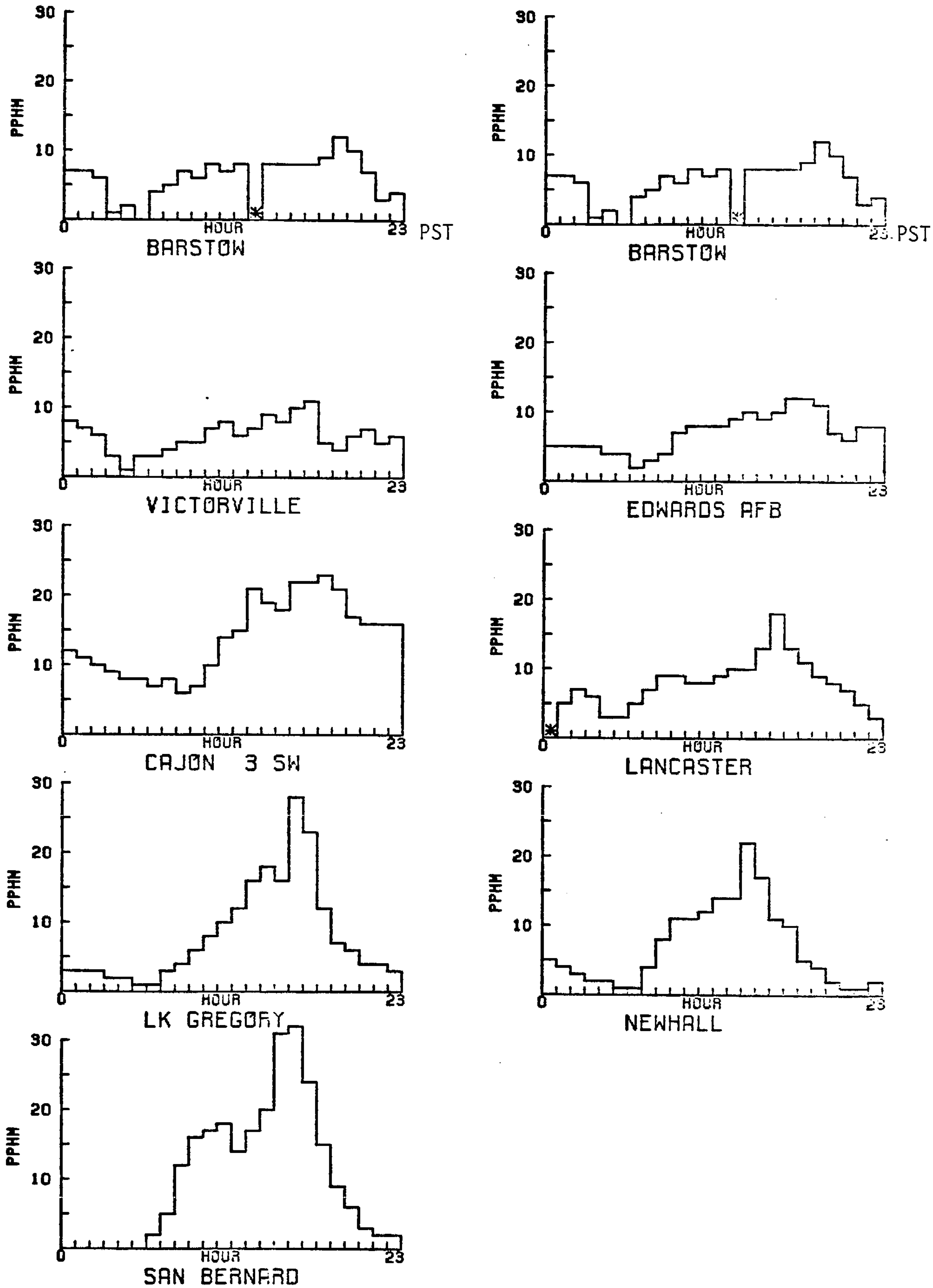
TIME OF MAXIMUM HOURLY OZONE CONCENTRATION - July 14,1981

Fig. 3.2.3



HOURLY OZONE CONCENTRATIONS - July 14,1981

Fig. 3.2.4



HOURLY OZONE CONCENTRATIONS - July 14,1981

Fig. 3.2.5

3.2.3 Aircraft Sampling - July 14-15, 1981

July 14

The flight pattern for the air quality sampling flight on July 14 is shown in Figure 3.2.6. A description of the numbered locations on the map is given in Table 3.2.6. Further details on the flight pattern are given in Table 3.2.7. A principal objective of the flight was to obtain a vertical cross section of the pollutants passing through Soledad Canyon.

Figure 3.2.7 shows the initial sounding made at Cable Airport at 1535 PDT in order to characterize the vertical structure within the basin. A pronounced pollutant layer was present over Cable Airport with a sharp top at about 900 m (msl). This made the thickness of the layer about 500 m. Peak ozone concentration in the layer was about 32 pphm. The highest hourly ozone concentration measured at Azusa on July 14 was 28 phm at 14 PDT.

Figure 3.2.8 consists of a horizontal traverse at 2134 m (msl) from Cable Airport to Acton (Pt. 2) in Soledad Canyon. Although the flight altitude was held constant the ozone concentration increased markedly on the north side of the San Gabriel Mountains. Over Acton the measured ozone concentration was about 16 pphm at 2134 m (msl).

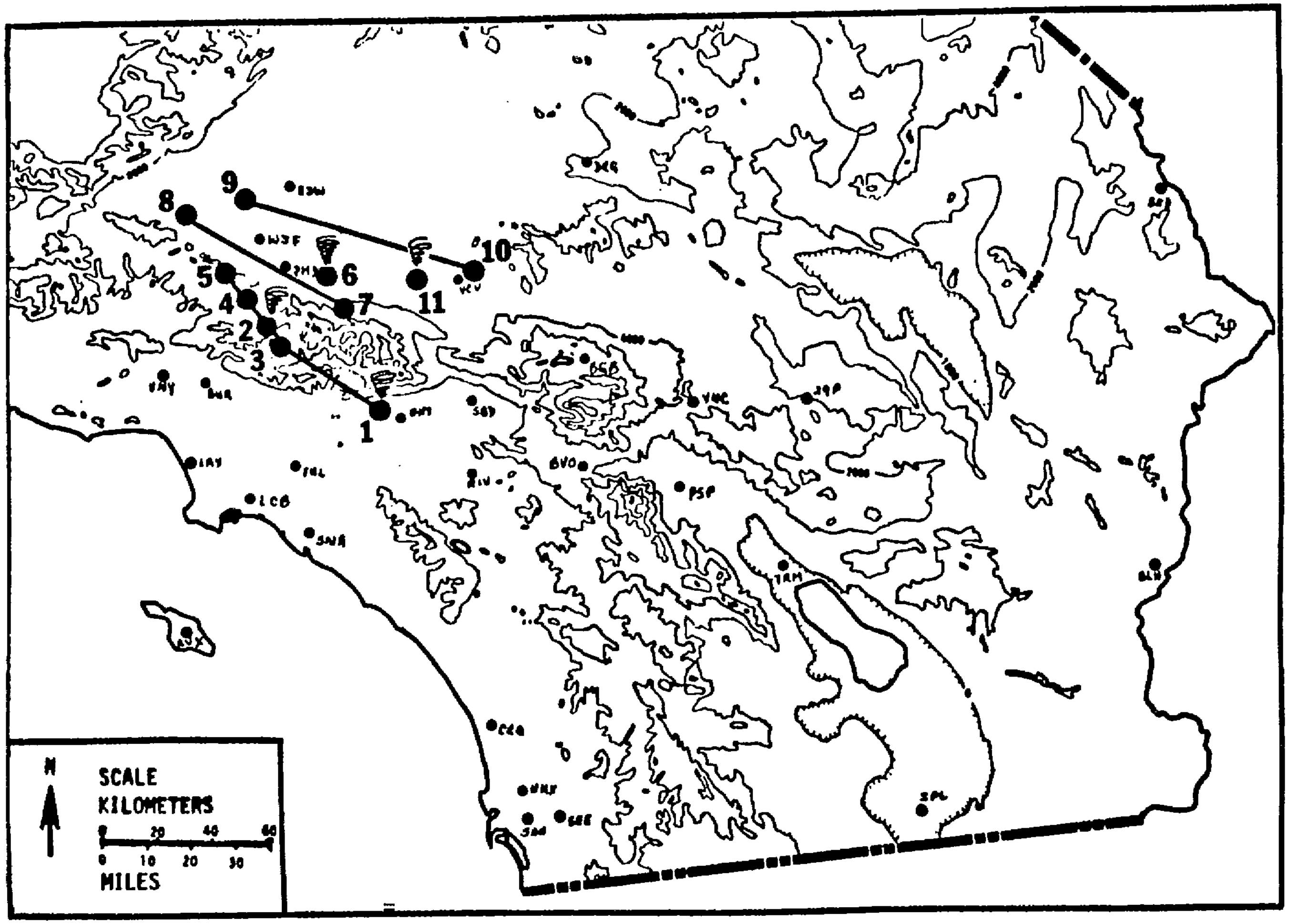
A spiral was then carried out at Acton at 1627 PDT (Figure 3.2.9). A deep layer of ozone was present over Acton extending to 2600 m (msl). Peak ozone concentration recorded was 20 pphm near the top of the layer. The wind at Acton at this time was from 250° to 290° in the lowest 850 m, shifting to southwest in the upper portion of the ozone layer. Southeasterly winds were present at higher levels.

Figure 3.2.10 shows a horizontal traverse fromm Pt. 3 to Pt. 4, across Soledad Canyon and directly over Acton. Flight altitude was 1219 m (msl) which is approximately 300 m over the terrain. The ozone profile shows a minimum near the center of the valley and higher concentrations near Pt. 3 and Pt. 4 on the edges of the valley.

Figure 3.2.11 shows another horizontal traverse along the same route. The higher flight altitude (1676 m-msl) permitted the flight to be extended somewhat further to the northwest (Pt. 5). Peak ozone concentrations along the traverse were 20 pphm, occurring slightly to the north of Acton.

The next traverse from Pt. 5 to Pt. 3 was flown at 2134 m (msl) and is shown in Figure 3.2.12. In this case the peak ozone concentration (17 pphm) was displaced slightly to the south of Acton.

The remainder of the flight pattern on July 14 was carried out in the desert areas. Figure 3.2.13 shows a sounding made about 3 km east of Palmdale. A low layer (top 500 m above ground) existed in the area capped by a stronger ozone layer aloft. Peak ozone concentration in the upper layer was about 17 pphm at 1500 m (msl).



MRI SAMPLING FLIGHT - July 14,1981

Fig. 3.2.6

Table 3.2.6

14 July 1981 Tape #252

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°06.2'	117°37.3'	Cable Airport
2	34°28.4'	118°12.0'	Acton
3	34°26.5'	118°10.5'	South end of Soledad Canyon
4	34°32.0'	118°13.2'	North end of Soledad Canyon
5	34°36.8'	118°16.0'	
6	34°34.6'	118°02.8'	2 miles east of Palmdale
7	34°31.5'	117°59.0'	Little Rock
8	34°44.2'	118°25.5'	Fairmont
9	34°52.3'	118°12.8'	Rosemond Airport
10	34°33.0'	117°18.0'	Victorville
11	34°32.6'	117°27.3'	Adelanto Airport

MRI FLIGHT SUMMARY

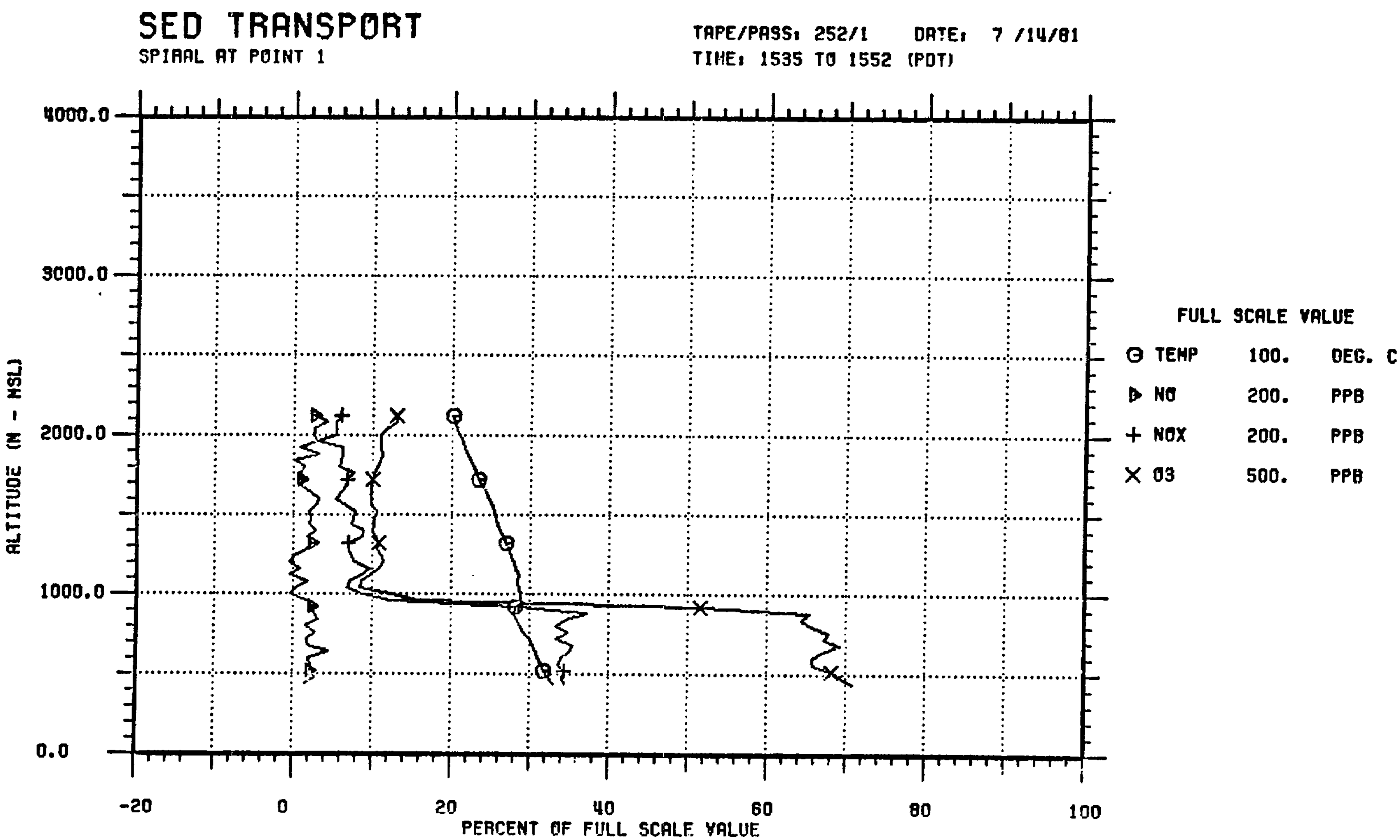
Date: July 14, 1981

SOUTHEAST DESERT OZONE TRANSPORT STUDY

Tape #: 252

Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start	End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1535	1552	Spiral	1	442	2134	N.A.	B1-12	Sfc Elev = 442 m
2	1553	1612	Traverse	1 - 2	2134		61.2 Km.		
3	1627	1644	Spiral	2	3353	853	N.A.	B13-29	Sfc Elev = 832 m
4	1647	1651	Traverse	3 - 4	1219		11.6 Km.	B30-36	Sampling in
5	1659	1706	Traverse	3 - 5	1676		21.1 Km.	B37-50	Soledad Canyon
6	1713	1720	Traverse	5 - 3	2134		21.1 Km.	B51-69	
7	1740	1802	Spiral	6	3353	792	N.A.	B70-86	Sfc Elev = 777 m
8	1811	1925	Traverse	7 - 8	1676		46.9 Km.	B87-101	
9	1832	1856	Traverse	9 - 10	1676		89.8 Km.	B102-126	
10	1903	1911	Spiral	11	945	1981	N.A.	B127-134	Sfc Elev = 938 m
11	1921	1930	Zero Spiral		1890	442	N.A.	0	Instrument calibration

Table 3.2.7



AIRCRAFT SOUNDING AT CABLE AIRPORT - July 14,1981

Fig. 3.2.7

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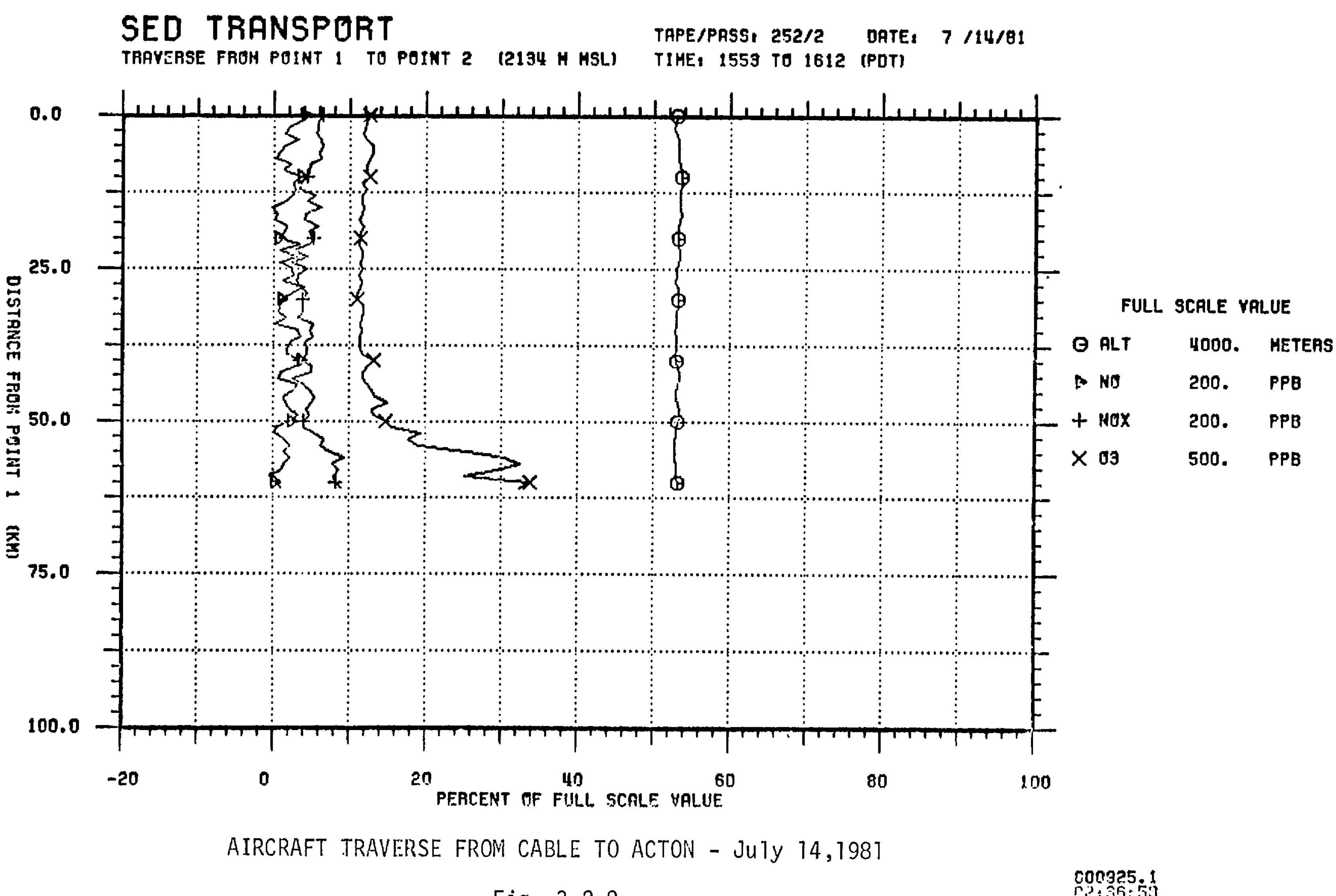
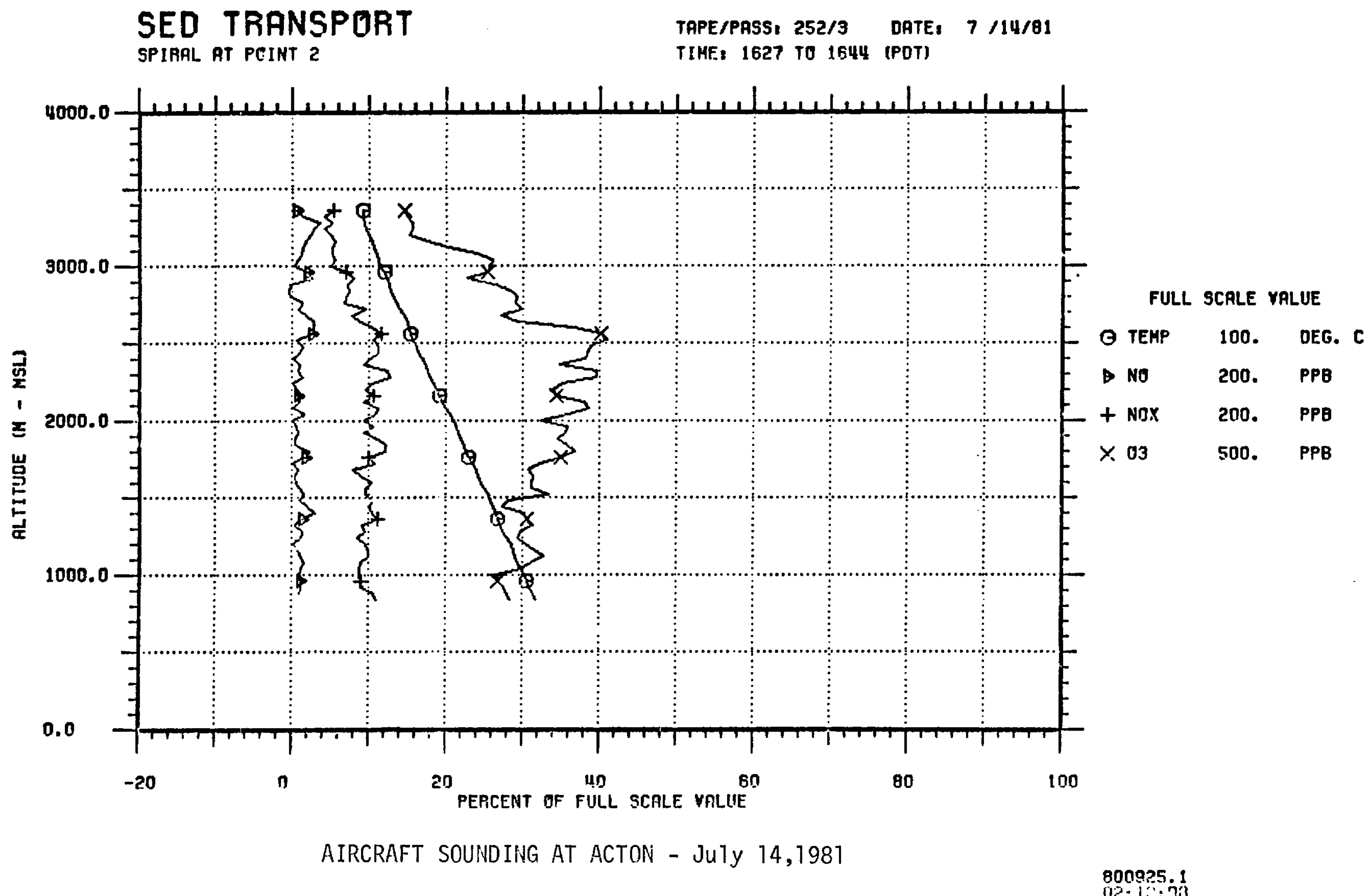
02:12:08



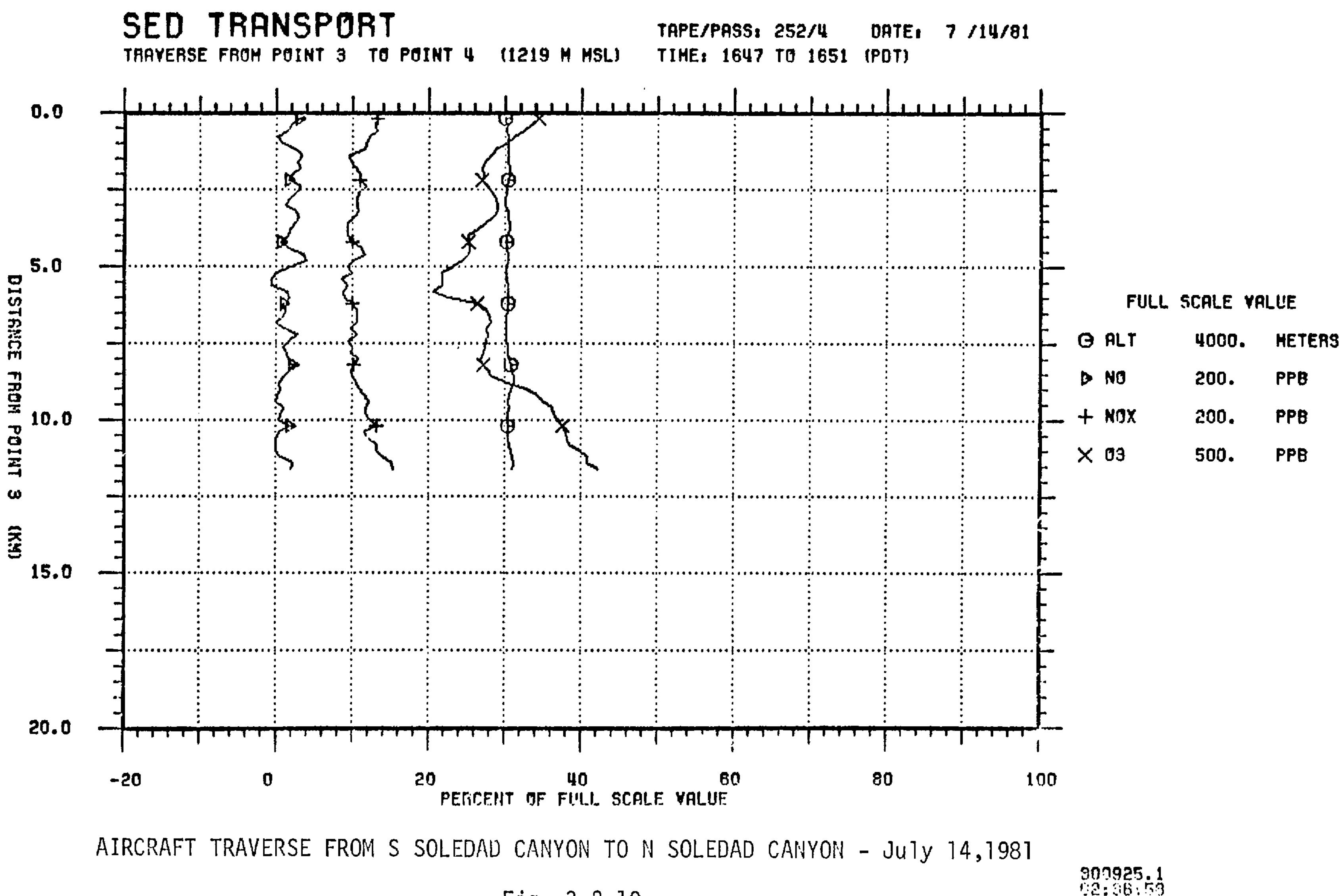
AIRCRAFT TRAVERSE FROM CABLE TO ACTON - July 14,1981

Fig. 3.2.8



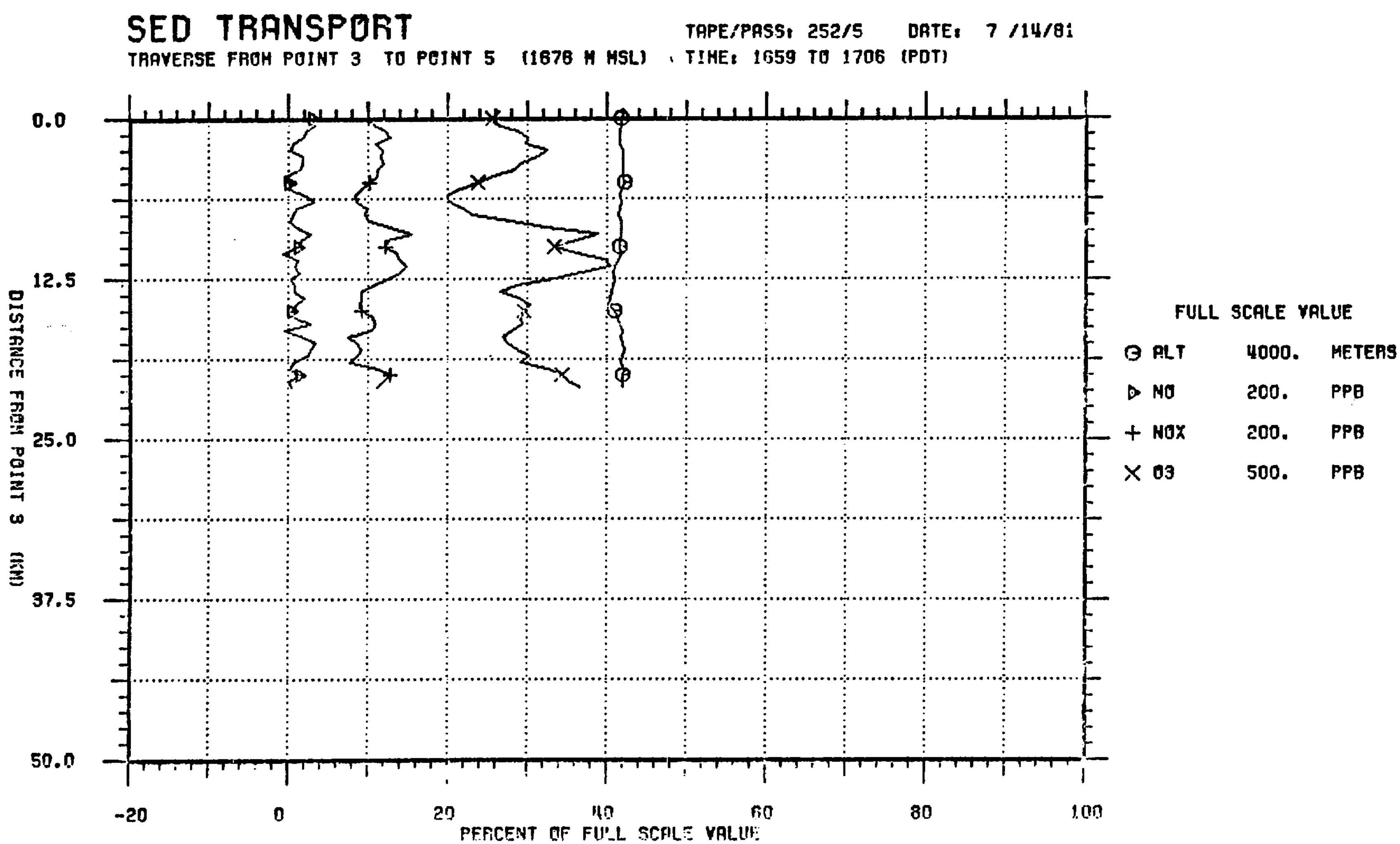
AIRCRAFT SOUNDING AT ACTON - July 14,1981

Fig. 3.2.9



AIRCRAFT TRAVERSE FROM S SOLEDAD CANYON TO N SOLEDAD CANYON - July 14,1981

Fig. 3.2.10



AIRCRAFT TRAVERSE FROM S SOLEDAD CANYON TO N SOLEDAD CANYON - July 14,1981

Fig. 3.2.11

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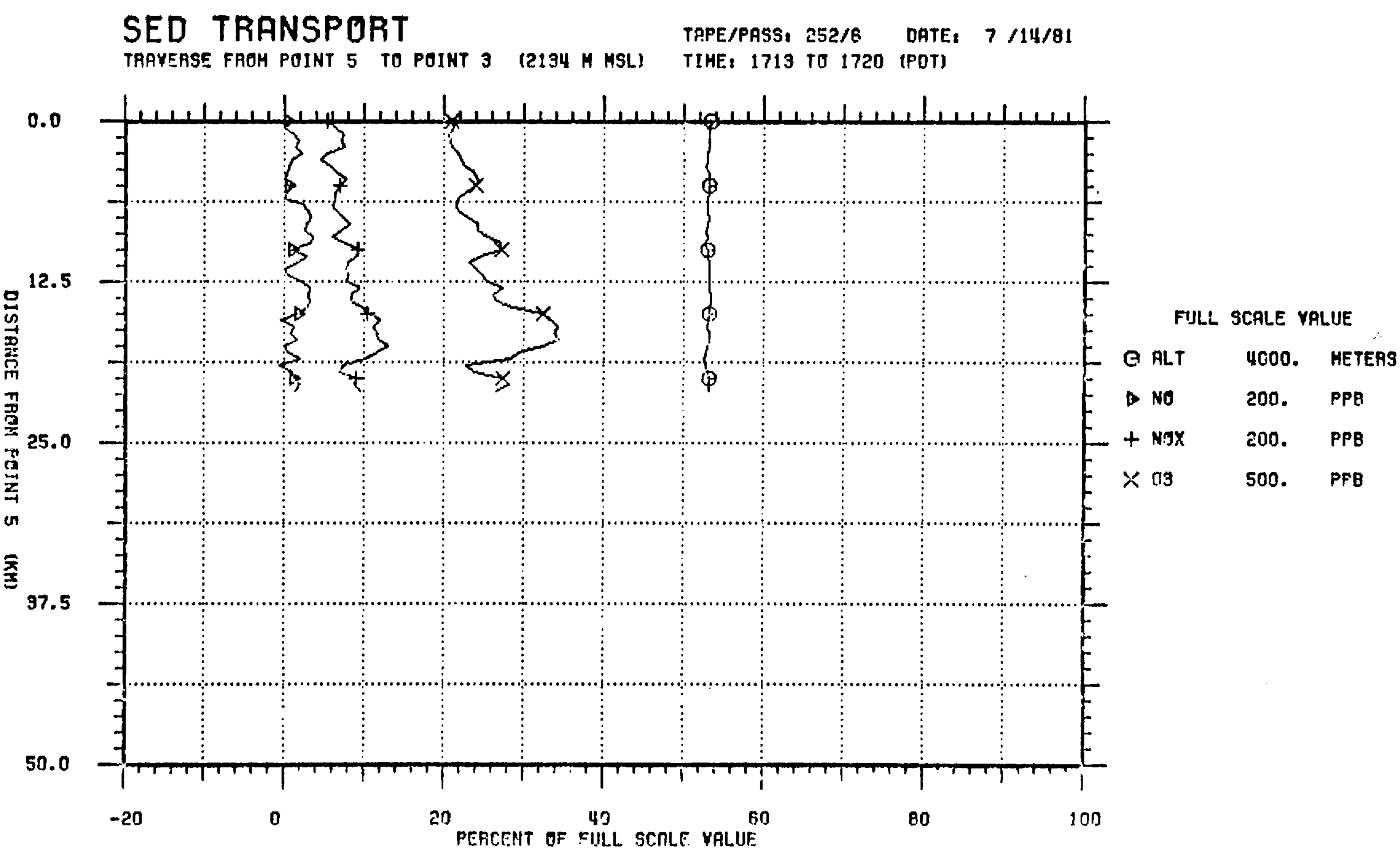
02:38:59



AIRCRAFT TRAVERSE FROM N SOLEDAD CANYON TO S SOLEDAD CANYON - July 14,1981

Fig. 3.2.12

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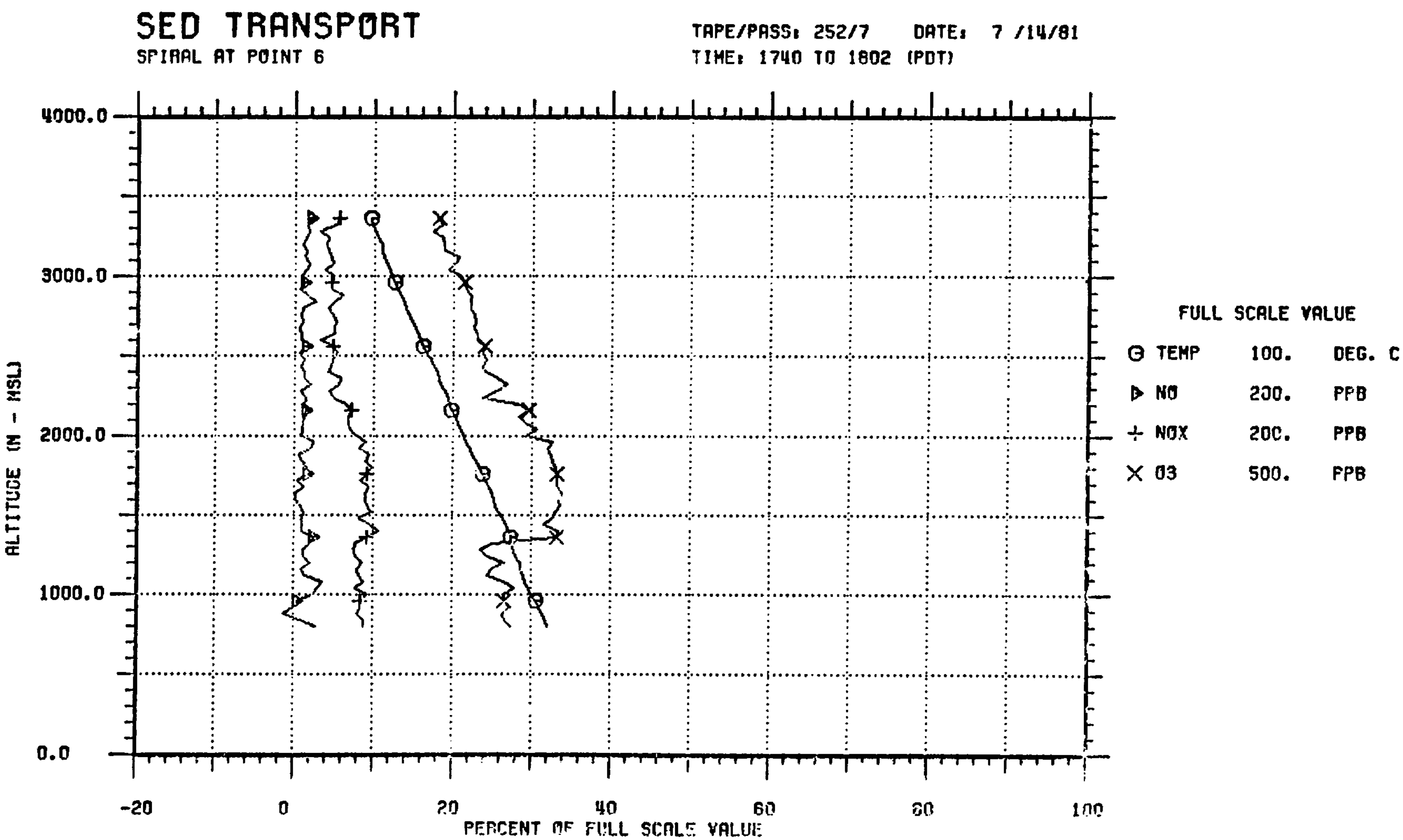
02:36:58



AIRCRAFT SOUNDING 5 MI W PALMDALE - July 14,1981

3.2.13

800925.1
02:12:08

Figure 3.2.14 represents a horizontal traverse from Little Rock to Fairmont (west of Rosamond) at an altitude of 1676 m (msl) which was approximately in the middle of the upper layer shown in Figure 3.2.13. From an ozone concentration near 17 pphm at Little Rock, the concentrations decreased to generally less than 10 pphm after passing Palmdale.

Another horizontal traverse (Figure 3.2.15) was flown beginning at 1832 PDT from Rosamond to Victorville at the same flight altitude (1676 m) as indicated for Figure 3.2.14. A distinct ozone plume was present along the traverse, beginning east of Lancaster and continuing almost to Victorville. Winds at flight level were from the west-southwest. It is apparent from the two horizontal traverses that the principal ozone plume moved to the south of Palmdale, to the north of Victorville and was headed toward the east-northeast.

The final sounding (Figure 3.2.16) on July 14 was made at Adelanto at 1903 PDT. The sounding shows an elevated ozone layer above a shallow surface layer with reduced ozone. The sounding is quite similar to the one made near Palmdale (Figure 3.2.13) although the reduced ozone layer was shallower at Adelanto. Ozone concentrations aloft were 16-17 pphm through a deep layer to 2000 m (msl).

July 15

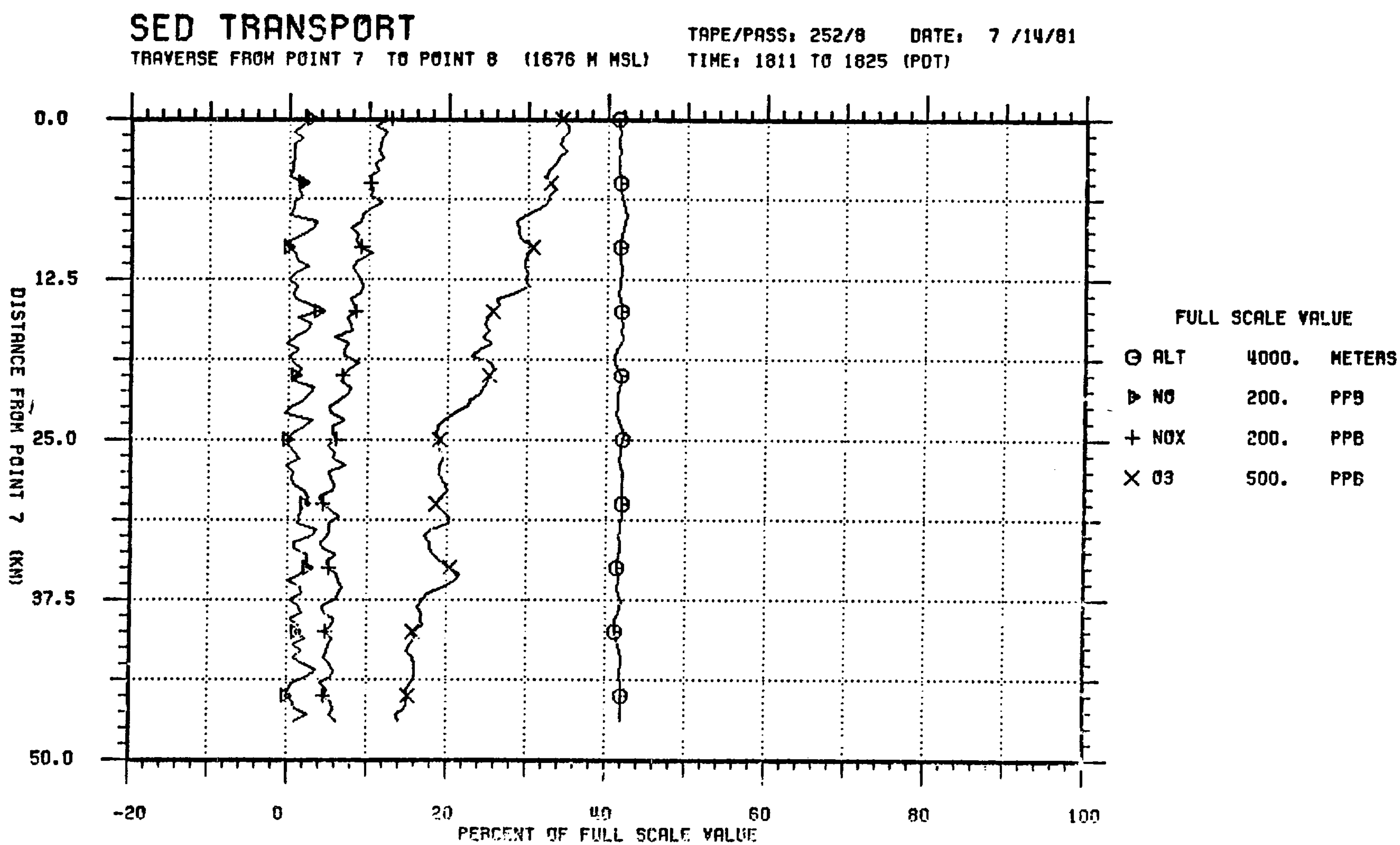
A short aircraft flight was made during the morning of July 15 to assess the extent of carry over of pollutants in the Mojave Desert from the previous evening. Figure 3.2.17 gives the flight pattern for July 15. The points marked on the map are described in Table 3.2.8. Details of the flight pattern are given in Table 3.2.9.

Figure 3.2.18 shows a sounding made at Cable Airport at 0834 PDT, shortly after takeoff on July 15. A marked, low-level layer was present containing high values of NO_x and reduced values of ozone. Aloft ozone concentrations averaged almost 10 pphm to a height of 1400 m (msl).

A sounding was then made about 2 miles east of Palmdale at the same location as Figure 3.2.13. The time of initiation of this sounding was 0906 PDT and the sounding itself is shown in Figure 3.2.19. The layers from the surface to 3000 m (msl) showed very low ozone concentrations.

A final sounding on July 15 was made at 0959 PDT at Barstow (Figure 3.2.20). Surface ozone concentrations were slightly reduced by the presence of NO_x. Aloft ozone concentrations averaged about 6 pphm.

Neither of the soundings carried out in the Mojave Desert (Figures 3.2.19 and 3.2.20) show any appreciable carry over of ozone or precursors from the previous day.



AIRCRAFT TRAVERSE FROM LITTLE ROCK TO FAIRMONT - July 14,1981

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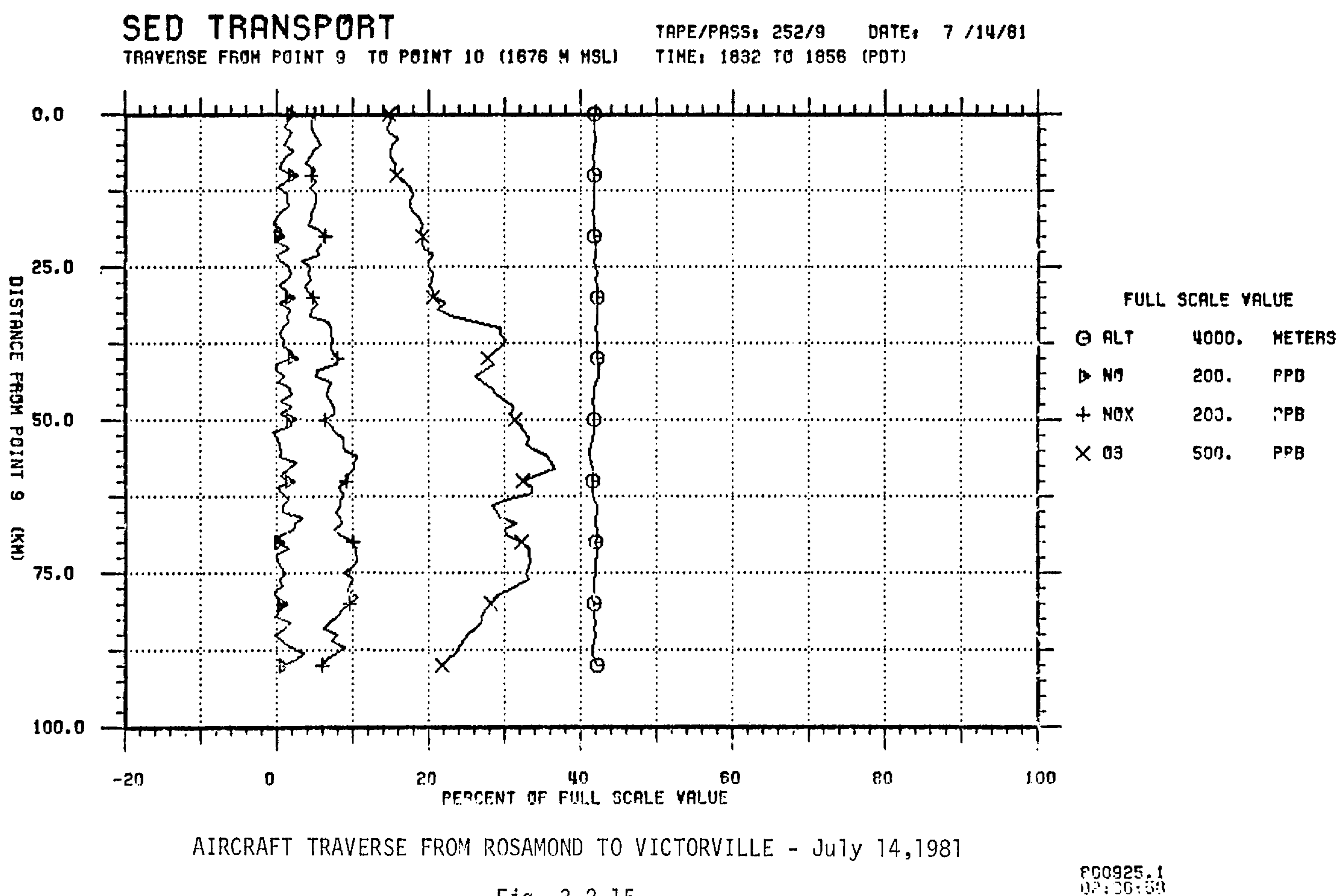
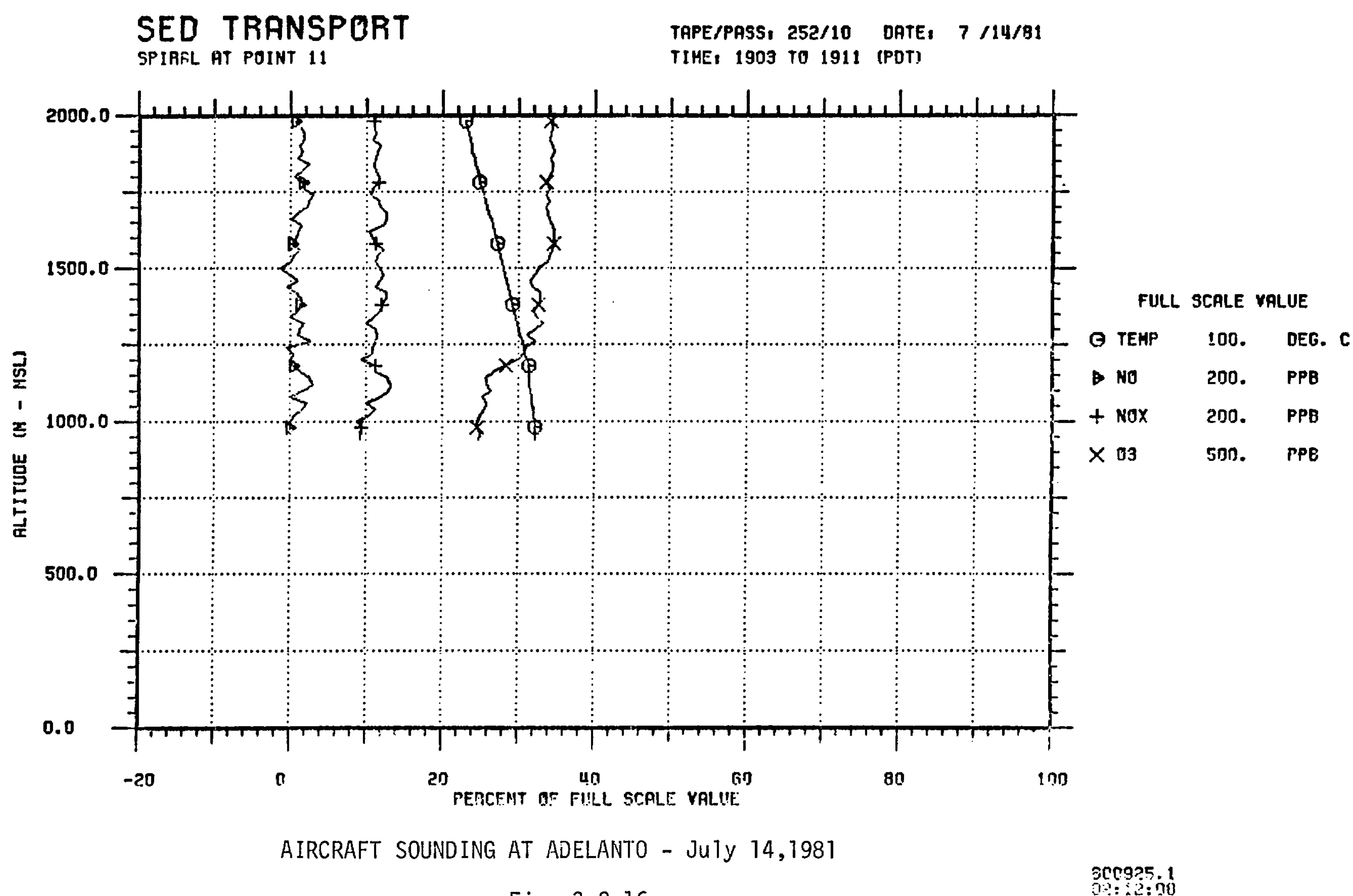
02:56:59

Fig. 3.2.14



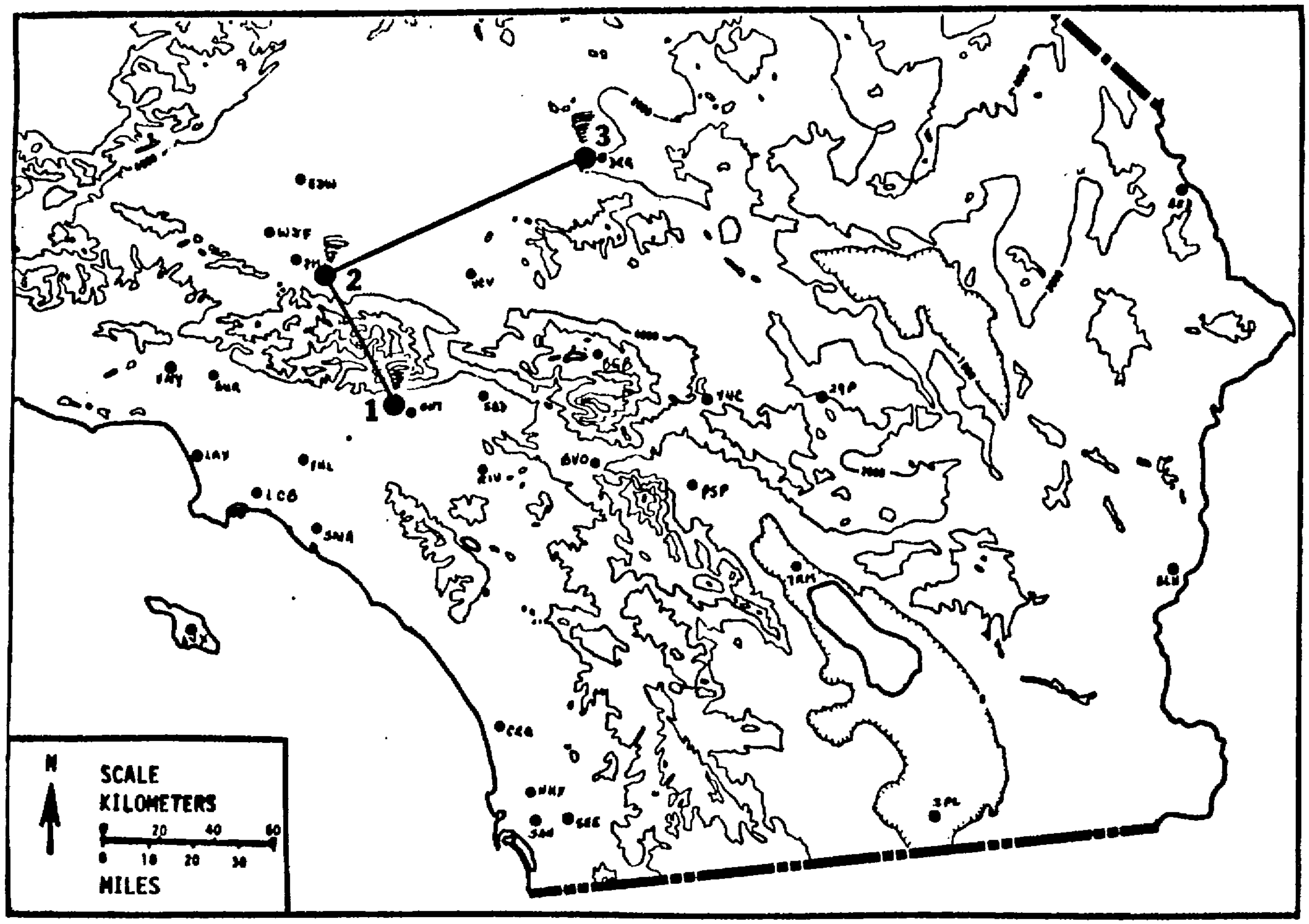
AIRCRAFT TRAVERSE FROM ROSAMOND TO VICTORVILLE - July 14,1981

Fig. 3.2.15



AIRCRAFT SOUNDING AT ADELANTO - July 14,1981

Fig. 3.2.16



NRI SAMPLING FLIGHT - July 15,1981

Fig. 3.2.17

Table 3.2.8

15 July 1981 Tape #253

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°06.0'	117°37.3'	Cable Airport
2	34°34.6'	118°02.8'	5 miles west of Palmdale
3	34°54.3'	117°03.0'	Barstow

MRI FLIGHT SUMMARY

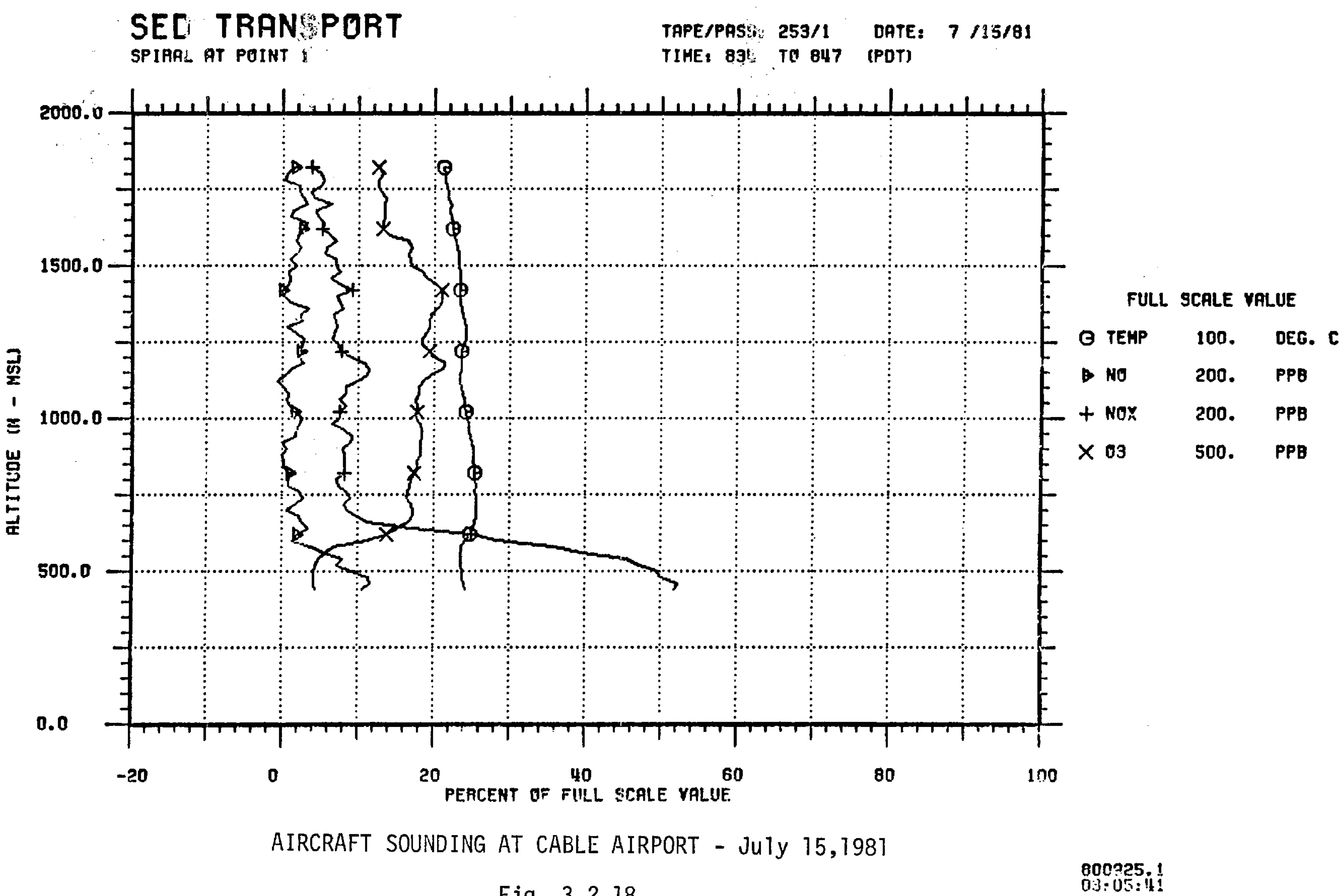
SOUTHEAST DESERT OZONE TRANSPORT STUDY

Date: July 15, 1981

Tape #: 253

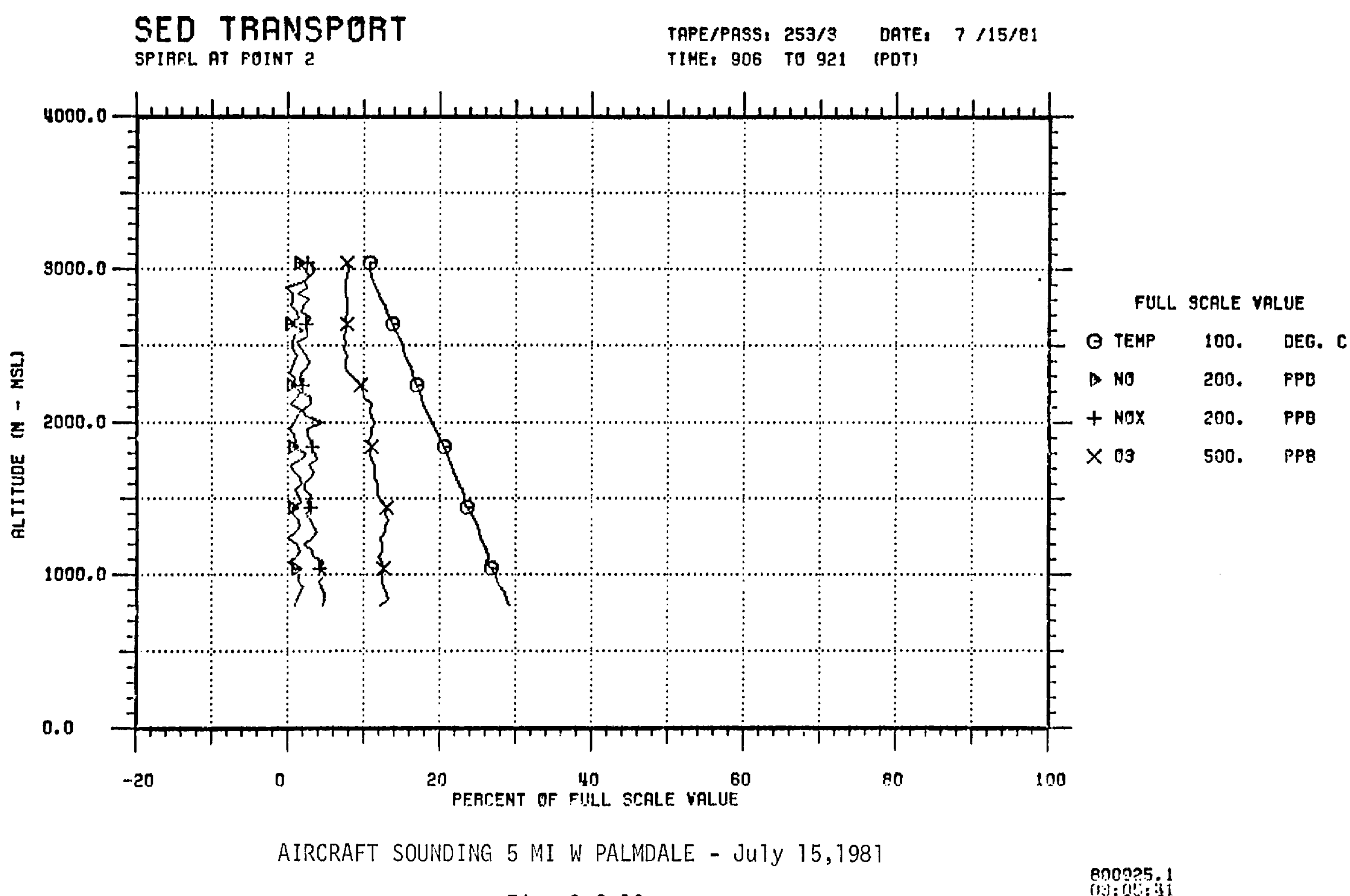
Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	834	847	Spiral	1	442-1829	N.A.	C1-10	Sfc Elev = 442 m
2	847	906	Traverse	1 - 2	1829-3048	61.2 Km.	C11-20	
3	906	921	Spiral	2	3048- 792	N.A.	C21-38	Sfc Elev = 777 m
4	928	956	Traverse	2 - 3	1219	97.4 Km.	C39-54	
5	959	1015	Spiral	3	640-2591	N.A.	C55-68	Sfc Elev = 634 m
6	1043	1056	Zero Spiral		2591- 442	N.A.	0	Instrument calibration

Table 3.2.9



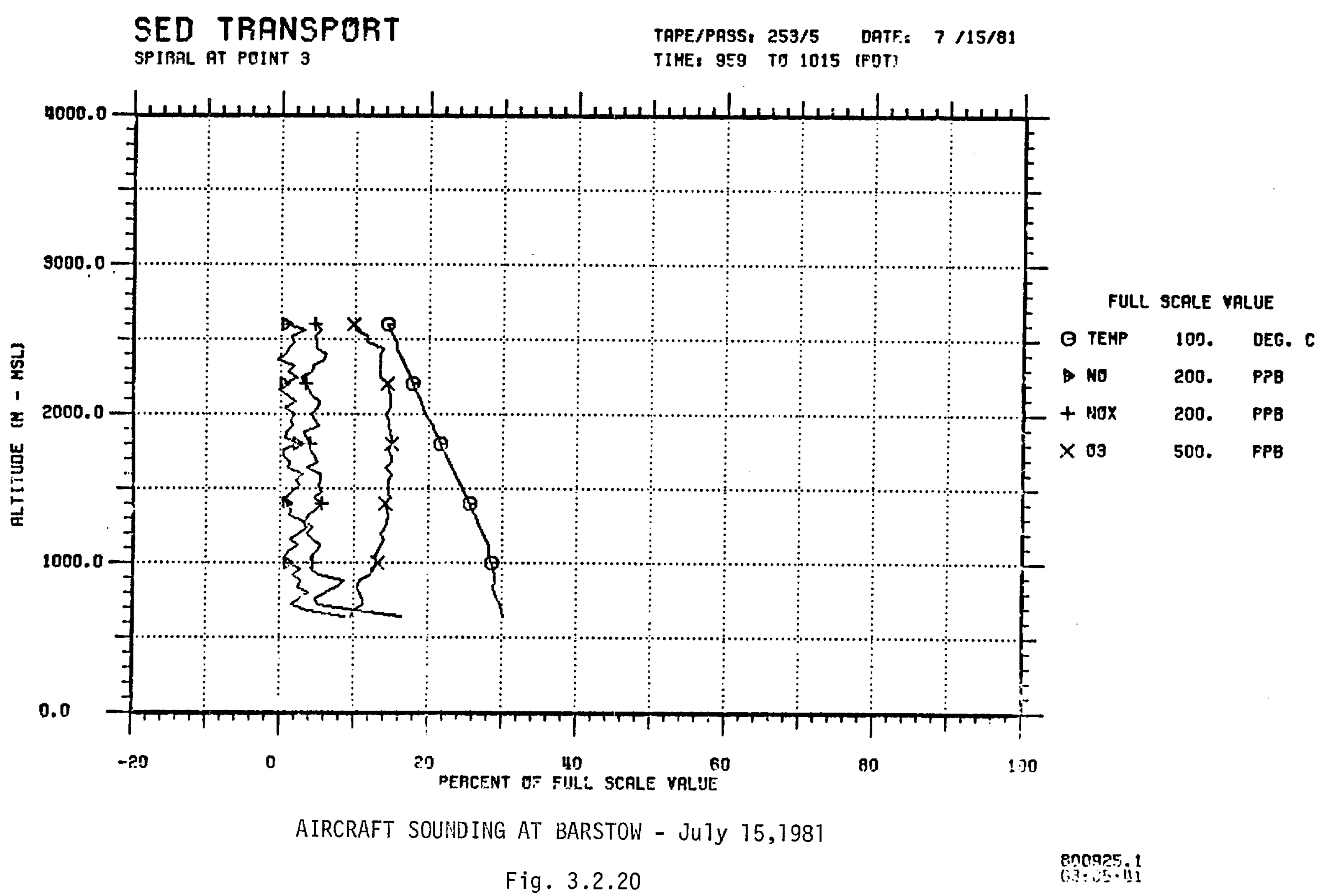
AIRCRAFT SOUNDING AT CABLE AIRPORT - July 15,1981

Fig. 3.2.18



AIRCRAFT SOUNDING 5 MI W PALMDALE - July 15,1981

Fig. 3.2.19



AIRCRAFT SOUNDING AT BARSTOW - July 15,1981

Fig. 3.2.20

3.2.4 Tracer Results - Test 2

Release Location: Sylmar
Date: July 14, 1981
Time: 1100-1500 PDT
Release Rate: 9.9 g/sec. SF_6

Surface winds at Sylmar during the release were south to south-southwest with light velocities increasing during the release period. Figs. 3.2.21 and 3.2.22 show surface streamlines at 10 PDT and 16 PDT, respectively. Onshore winds were apparent at 10 PDT in the LAX area but the flows through Soledad Canyon and Cajon Pass were not well established. By 16 PDT the flows through the passes into the desert were moderately strong at Lancaster, Palmdale and Victorville. A small eddy was present in the western part of the Mojave Desert (16 PDT) and the accompanying weak velocities at Mojave and Edwards AFB suggested a weak coupling with the moderate flow through Soledad Canyon.

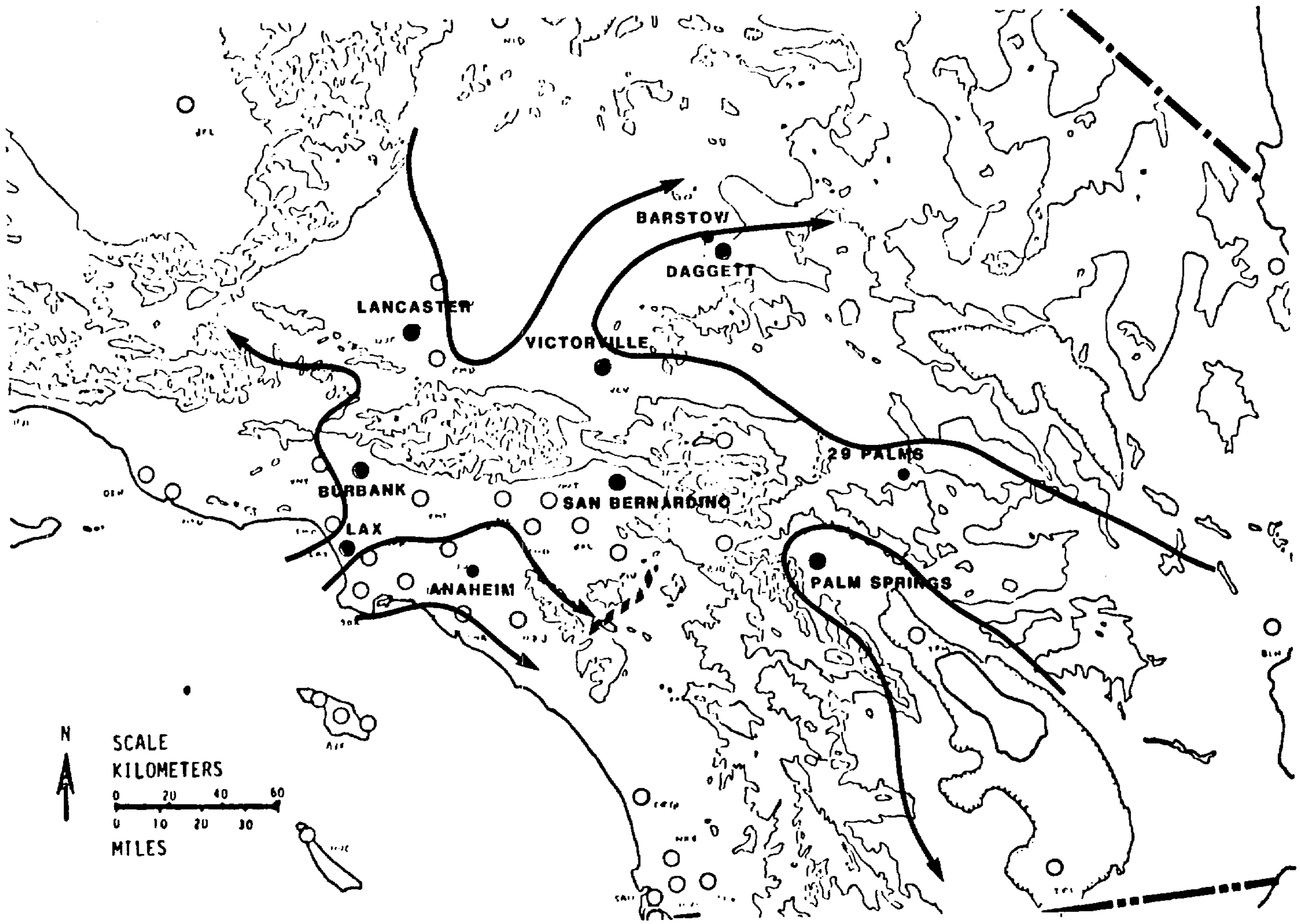
July 14

The trajectory of the tracer material is shown in Fig. 3.2.23. Principal impacts were observed near Lancaster, at Edwards AFB, at Victorville, and at Barstow. Times and locations of maximum observed concentrations are shown in the figure. From Sylmar to Barstow (152 km) an average travel velocity of 6.0 m/s is indicated.

The main tracer plume apparently passed slightly south of Palmdale and moved eastward to a little north of Victorville. From there, the apparent trajectory was to the northeast since Lucerne Valley did not receive any tracer material until 20 PDT as a result of a prevailing east to southeast wind flow.

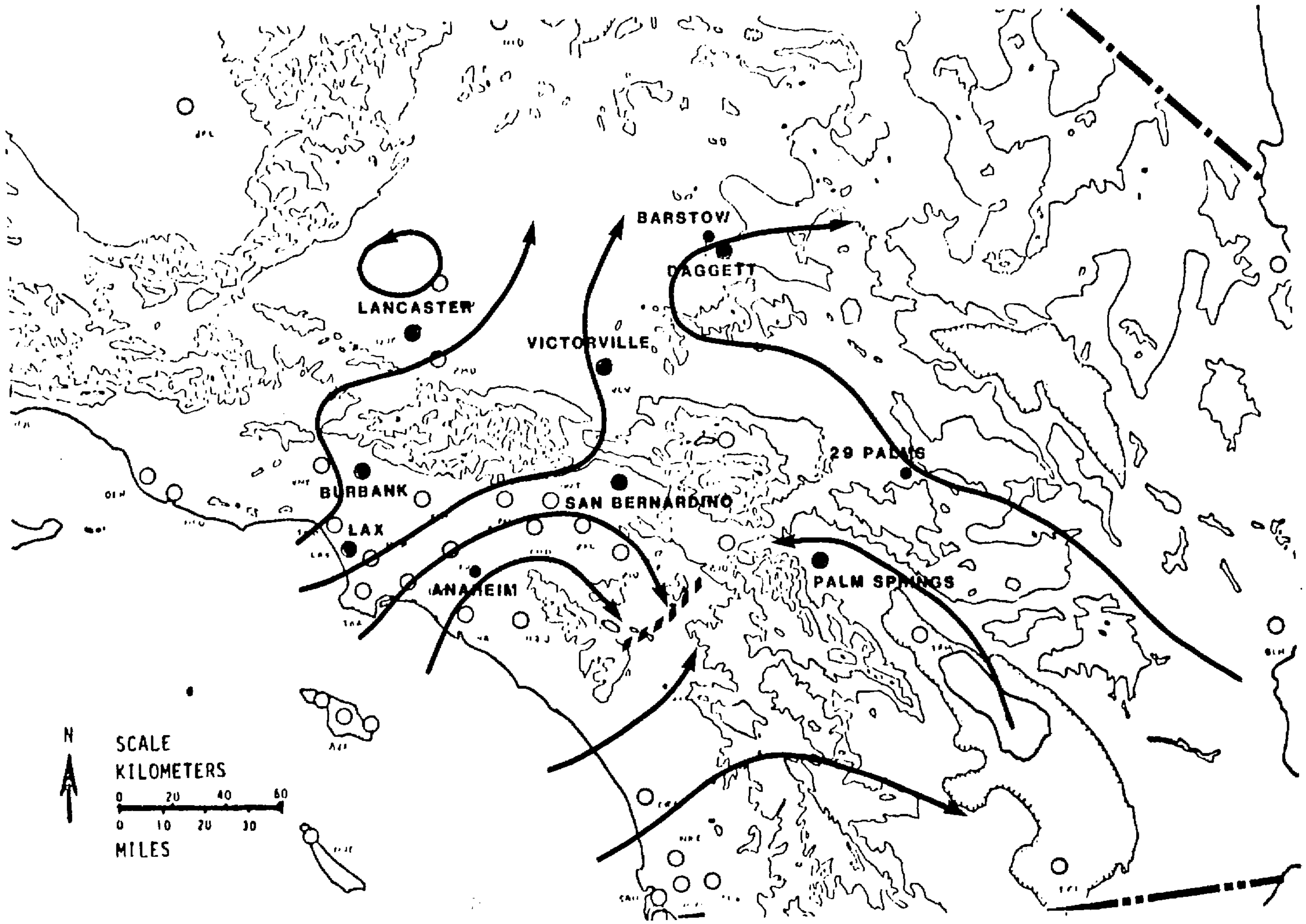
The impact of the tracer plume at Edwards AFB was relatively minor (25 ppt maximum at 17 PDT) and significant concentrations were observed for only two hours. Principal tracer concentrations in the eastern Mojave Desert were found in a triangle bounded by Victorville, Barstow and the intersection of Highways 395 and 58 (to the east of Boron).

Fig. 3.2.24 shows the Xu/Q values computed from the tracer data of Test 2. An average wind speed of 2.0 m/s during release was used to determine the values plotted on the graph. Maximum observed tracer concentrations were used in the calculations to approximate the centerline concentrations insofar as possible. The calculated Xu/Q values correspond to C or D stability with the exception of one point for which the centerline concentration may not have been observed.



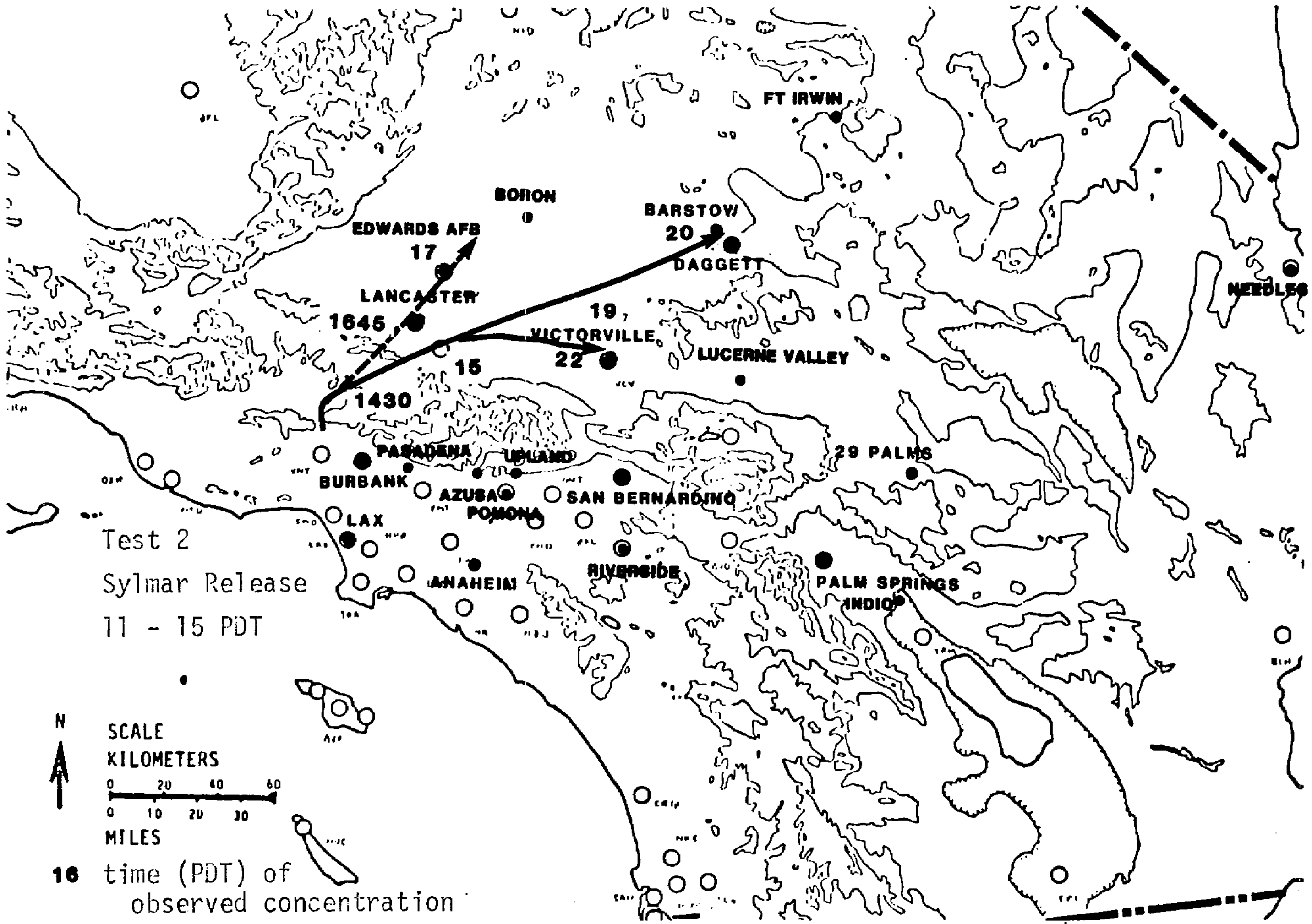
STREAMLINE MAP (10 PDT) - July 14,1981

Fig. 3.2.21



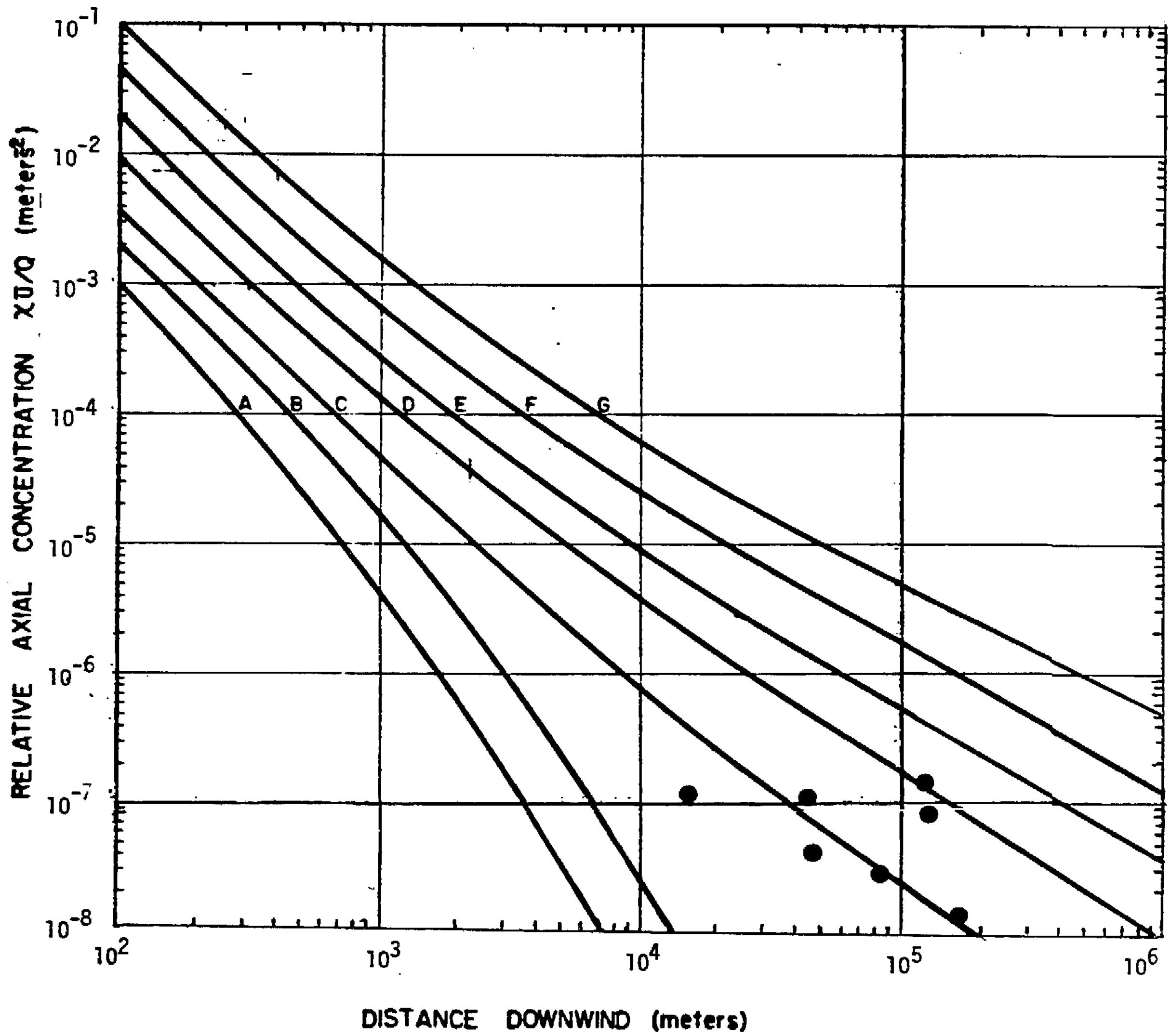
STREAMLINE MAP (16 PDT) - July 14,1981

Fig. 3.2.22



TRACER TRAJECTORIES - July 14,1981

Fig. 3.2.23



CALCULATED XU/Q VALUES - Test 2

July 14,1981

Fig. 3.3.24

July 15

Extensive automobile sampling was carried out on July 15 with a primary purpose to investigate potential carry-over of tracer into the desert. Automobile sampling covered the area from Needles through 29 Palms to Indio from Ft. Irwin to Barstow to Lancaster and to San Bernardino (through Victorville). No significant tracer concentrations were found during the sampling which extended from 0849 PDT to 1848 PDT.

A portion of the automobile routes covered the triangular area from Pasadena to San Bernardino to Riverside. Between 1100 and 1800 PDT a considerable amount of SF_6 was noted, primarily in the area from Azusa to Pomona to Upland. Highest concentrations ranged from 20-30 ppt to over 150 ppt during the afternoon. By late afternoon (1600-1700 PDT) several observations were made of peak concentrations in the vicinity of Pomona and the intersection of Highways 10 and 210. The source of this tracer material is somewhat unclear and is discussed further in section 4.7.

3.3 Test 3 18-19 July 1981, Cajon Junction Release (1300-1700 PDT, 7/18/81)

3.3.1 Meteorology

General

A weak surface pressure trough existed in Nevada on July 18 (Figure 3.3.1) with surface pressures rising in the Pacific Northwest during the period July 17-19. A minor pressure ridge aloft moved into Southern California from July 17 to 18, resulting in weak, upper level winds over the area. The normal, inland surface pressure trough was not as well developed as usual during the summer.

Table 3.3.1 gives the observed meteorological parameters on July 18. The 850 mb temperature at Vandenberg AFB was slightly above the average for July. Pressure gradients to the inland areas were relatively weak. The morning inversion height at UCLA was 465 m which is slightly higher than the median for July (Keith, 1980). Temperatures in the inland areas were relatively warm.

From an air quality standpoint, July 18 could be rated as somewhat greater pollution potential than average for July with relatively stagnant wind transport conditions.

Transport Winds

Surface winds at Cajon Junction during the release period on July 18 are shown in Table 3.3.2:

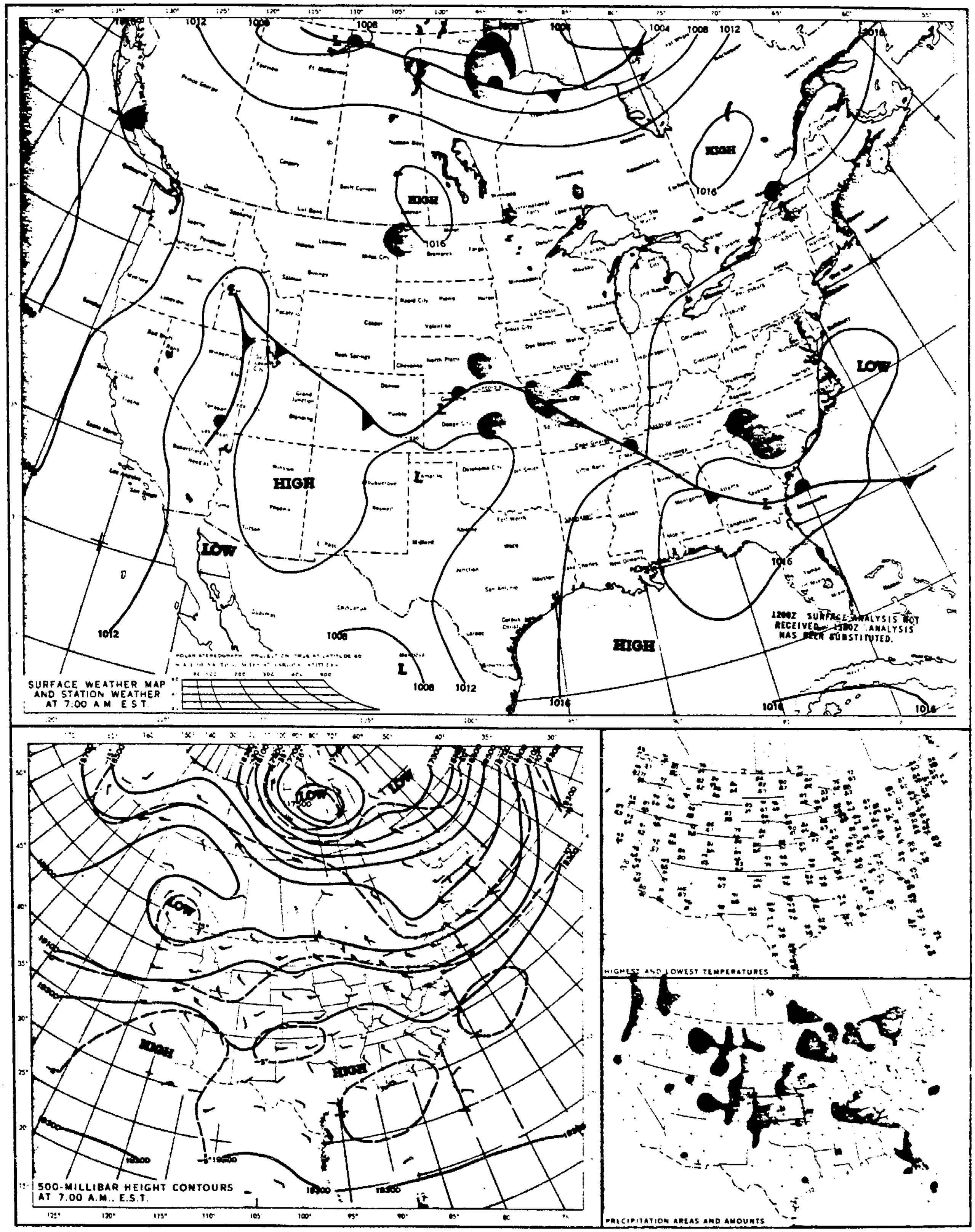
Table 3.3.2

SURFACE WINDS AT CAJON JUNCTION DURING AND AFTER RELEASE

JULY 18, 1981

Time (PDT)	Direction (°)	Speed (m/s)
13	130	5.9
14	120	6.8
15	120	7.5
16	120	7.5
17	120	7.0
18	120	6.1
19	130	6.0
20	150	4.0
21	180	3.0
22	210	2.0

SATURDAY, JULY 18, 1981



WEATHER MAP

July 18,1981

Fig. 3.3.1

Table 3.3.1

METEOROLOGICAL PARAMETERS

JULY 18, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	21.0°C
Edwards AFB	(0530 PDT)	25.1
Ontario	(0830 PDT)	-
UCLA	(0600 PDT)	20.6
Pressure Gradients	(0800 PDT)	
LAX - Daggett		1.9 mb
LAX - Bakersfield		0.1
Maximum Surface Temperature		
Ontario		99°F (37.2°C)
Palm Springs		110 (43.3)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	16.8°C (465 m)
Rialto	(0700 PDT)	17.2 (Surface)
Ontario	(0830 PDT)	-
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	22.9°C (834 m)
Rialto	(0700 PDT)	23.9 (1200 m)
Ontario	(0830 PDT)	-

* All heights are msl

Surface winds during the release period (13-17 PDT) were consistently from the southeast at the release site with moderately strong velocities. The direction of the flow represents transport through the pass into the desert areas. The moderate wind velocities tend to dilute the tracer significantly at the release site.

Table 3.3.3 gives the surface wind observations at Lancaster, Victorville and Palm Springs on July 18 and 19. The wind flow at Lancaster was generally directed from Newhall/Mint Canyon toward the desert except for brief periods during the morning.

At Victorville, south to southwest winds prevailed from 14-22 PDT on July 18 and from 12-20 PDT on July 19. Otherwise winds were light and variable.

At Palm Springs, northwesterly winds bringing air from San Gorgonio Pass began at 20 PDT on July 18 but did not make a significant appearance on July 19.

Mixing Heights

Observed and predicted mixing heights for July 18 are shown in Table 3.3.4. In the inland areas the mixing layer became relatively deep during the afternoon. The observation at Rialto at 1521 PDT showed a height of 1250 m (msl) for the top of the layer. The inversion was predicted to be broken at San Bernardino according to the morning temperature sounding and the afternoon surface temperatures. This prediction was supported by a marked increase in visibility reported at about 11 PDT (Table 3.3.5). A significant increase also occurred at Ontario but not until 13 PDT. As indicated previously, observed mixing layer tops near Cajon Pass tended to be higher than observed in the desert or in the basin areas.

Table 3.3.5

OBSERVED VISIBILITIES - JULY 18, 1981

Time (PDT)	San Bernardino	Ontario
10	5 miles	2 miles
12	20	4
14	12	7
16	12	6
18	10	25

Table 3.3.3

SURFACE WINDS - JULY 18-19, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	270°/ 4.1 m/s	Calm	-
08	070 / 2.6	180°/1.0 m/s	140°/2.6 m/s
10	250 / 4.6	170 /1.0	100 /2.6
12	260 / 5.1	050 /0.5	Calm
14	270 / 8.8	180 /6.2	050 /2.1
16	250 /12.4	210 /4.6	060 /3.1
18	260 /12.9	210 /7.7	080 /4.1
20	260 /10.8	230 /3.1	290 /7.7
22	260 / 7.7	230 /1.6	270 /4.1
24	260 / 5.1	Calm	-
02	290 / 4.6	230 /1.6	-
04	270 / 6.2	Calm	-
06	290 / 2.6	Calm	-
08	070 / 2.6	180 /2.1	Calm
10	250 / 6.7	Calm	Calm
12	270 / 8.2	200 /1.0	110 /3.1
14	260 / 7.7	230 /2.1	130 /2.6
16	250 /11.3	170 /5.1	080 /5.1
18	250 /12.4	200 /6.7	080 /5.1

Table 3.3.4

MIXING HEIGHTS - JULY 18, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	465 m	150 m
	1200	374	150
Ontario	0830	-	290
	1430	-	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Rialto AP	1521 PDT	1250 m	450 m
Cajon Junction	1549	1500	900
Hesperia AP	1622	1450	1000
W of Cajon Pass	1652	1900	1200
Victorville	1810	1200	900

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	-	290 m
San Bernardino	Inv. Broken	360
Edwards AFB	2285	725

3.3.2 Regional Pollutant Levels

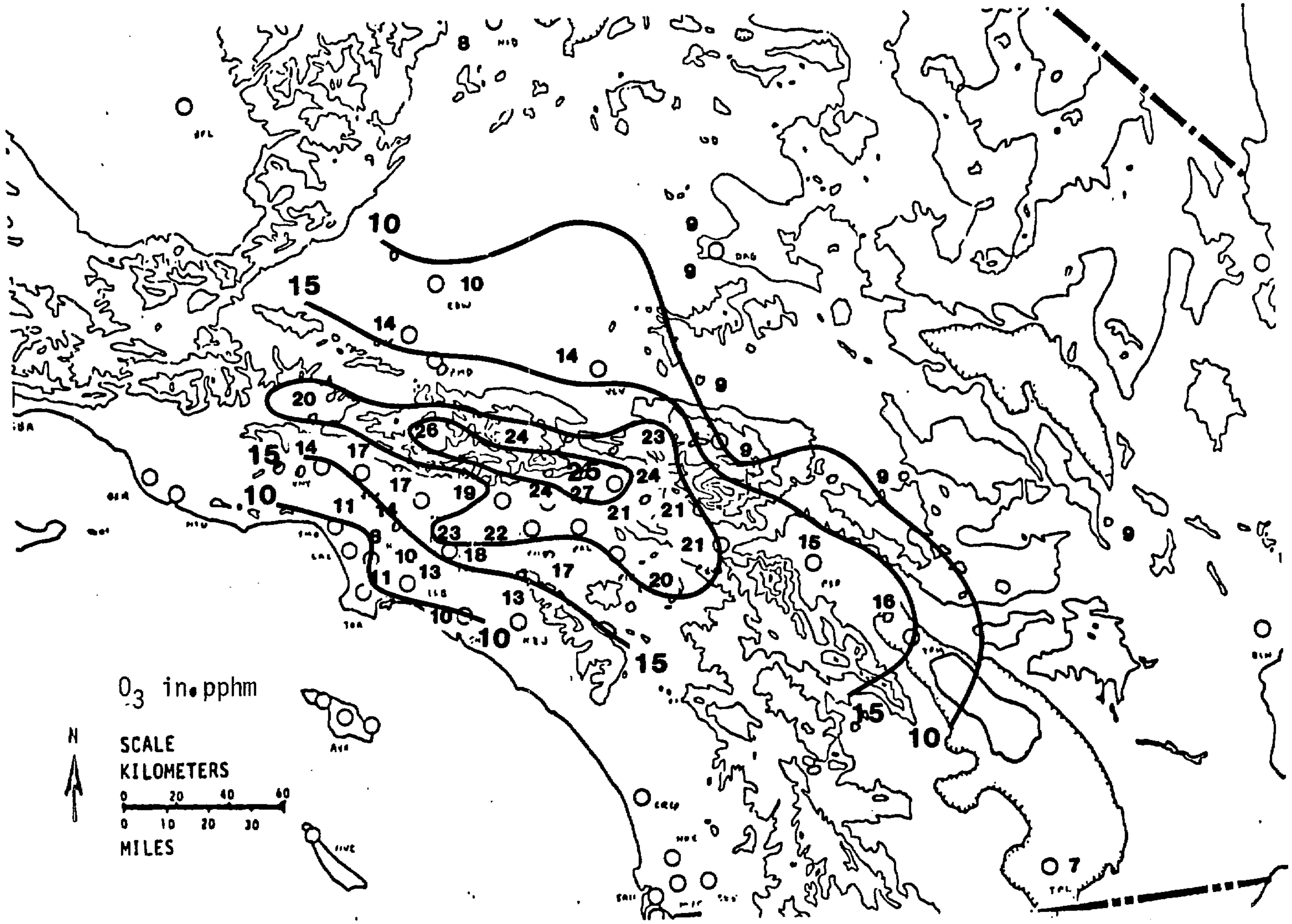
Figure 3.3.2 shows a map of the peak hourly ozone concentrations for July 18 in the Los Angeles basin and desert areas. Maximum ozone concentration observed in the figure occurred at Fontana (27 pphm) but Mt. Wilson indicated a peak of 26 pphm and, Pomona, Mt. Baldy and San Bernardino all had peak hourly values of 24 pphm. Mt. Wilson, in particular, had a peak concentration well above Pasadena (17 pphm) although the wind flow is frequently directed from Pasadena toward Mt. Wilson during the afternoon. The desert areas immediately downwind of the principal passes showed relatively large peak ozone concentrations on July 18. Indio and Palm Springs had peak values of 16 and 15 pphm, respectively. Victorville and Lancaster showed maximum hourly concentrations of 14 pphm.

A map of the time of the peak hourly ozone concentrations on July 18 is given in Figure 3.3.3. All of the desert areas with the exception of Iron Mountain and El Centro show late afternoon or evening peaks, suggestive of transport from the basin. The pattern of arrival of the peaks at Victorville and Lucerne Valley suggest that the transport through Cajon Pass carried ozone and precursors into Lucerne Valley rather than northward to Barstow on this day.

Banning indicates a peak hourly concentration (23 PDT) much later than would be expected from the nearby locations. This is clearly apparent from the plots of hourly concentrations shown in Figure 3.3.4. Riverside, Palm Springs and Indio show a straightforward transport into the desert but with a delayed peak at Banning.

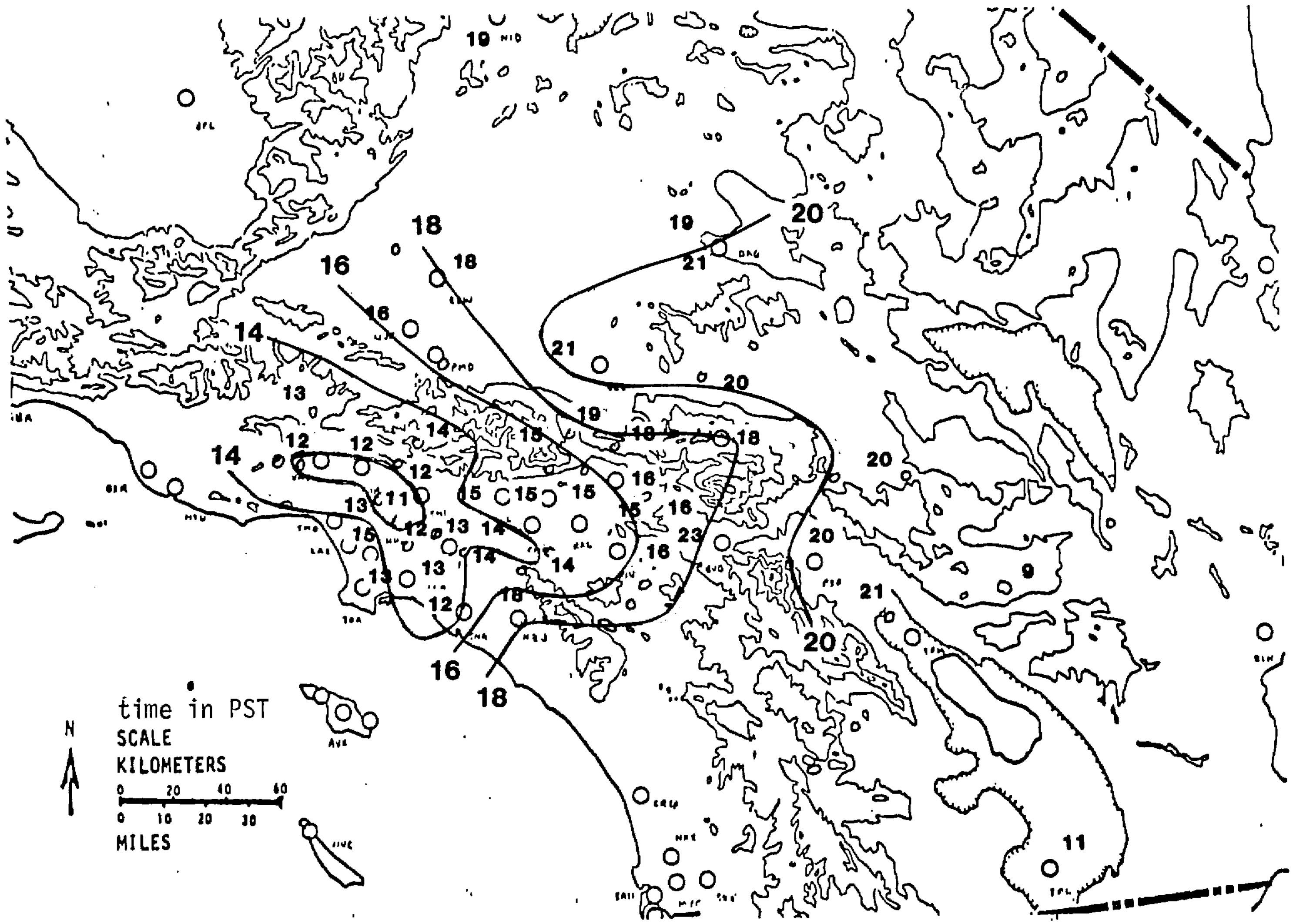
The timing of the peaks in the mountain areas (Figure 3.3.4) show progressively later occurrences for the eastern locations. Lake Gregory again (see also July 9) indicates increased ozone in the late evening. The timing of the peak at Fawnskin suggests transport from the basin but the magnitude of the peak is relatively small.

In Figure 3.3.5 concentrations along the transport routes through Mint Canyon and Cajon Pass are shown. The San Bernardino to Victorville sequence shows a clear indication of transport from the basin. As noted earlier, the peak at Barstow does not indicate that material passing through Victorville reached Barstow on July 18. At the same time, the route from Newhall through Edwards AFB to Barstow suggests that the evening peak at Barstow probably passed along that route.



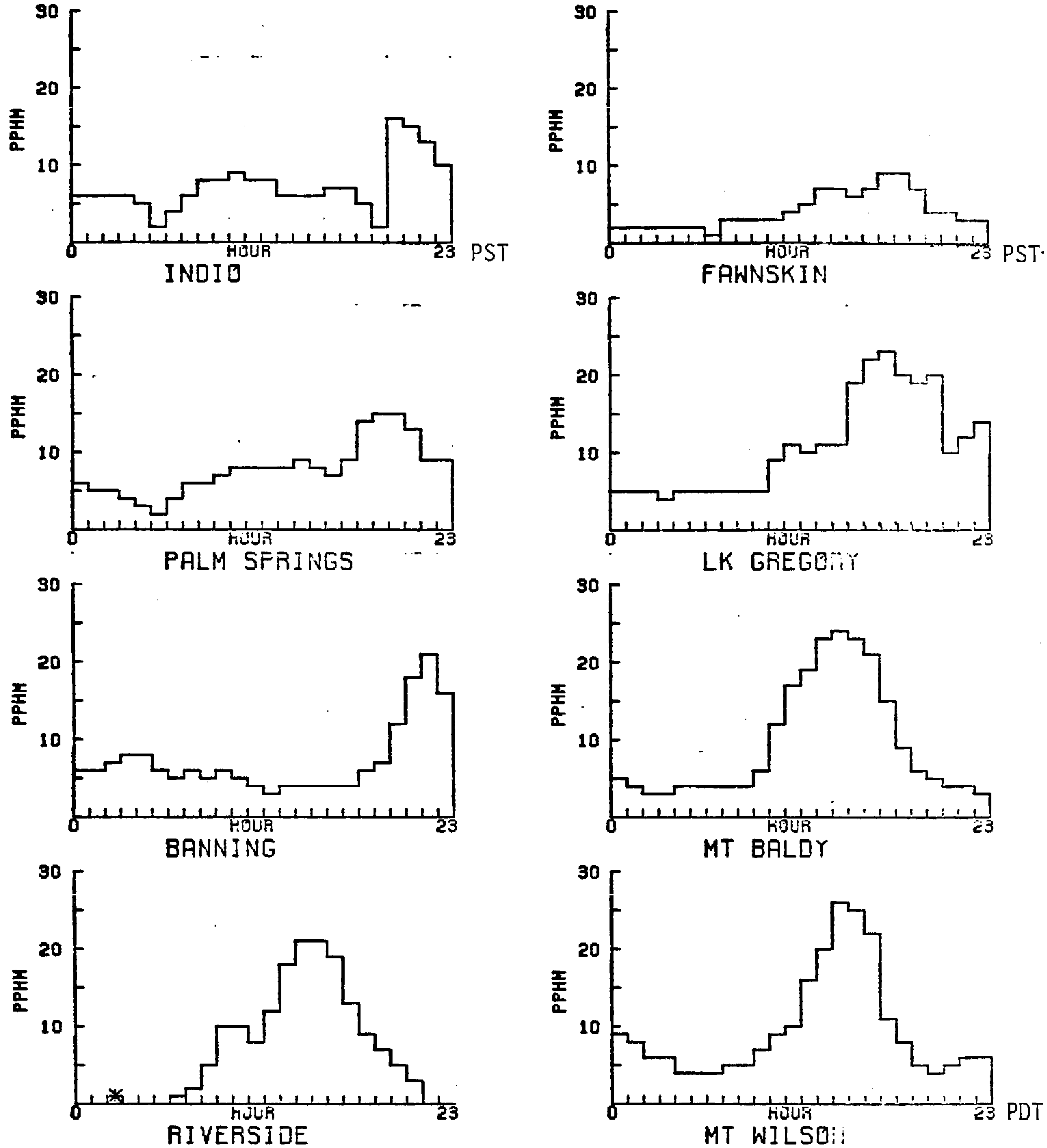
MAXIMUM HOURLY OZONE CONCENTRATIONS - July 18,1981

Fig. 3.3.2



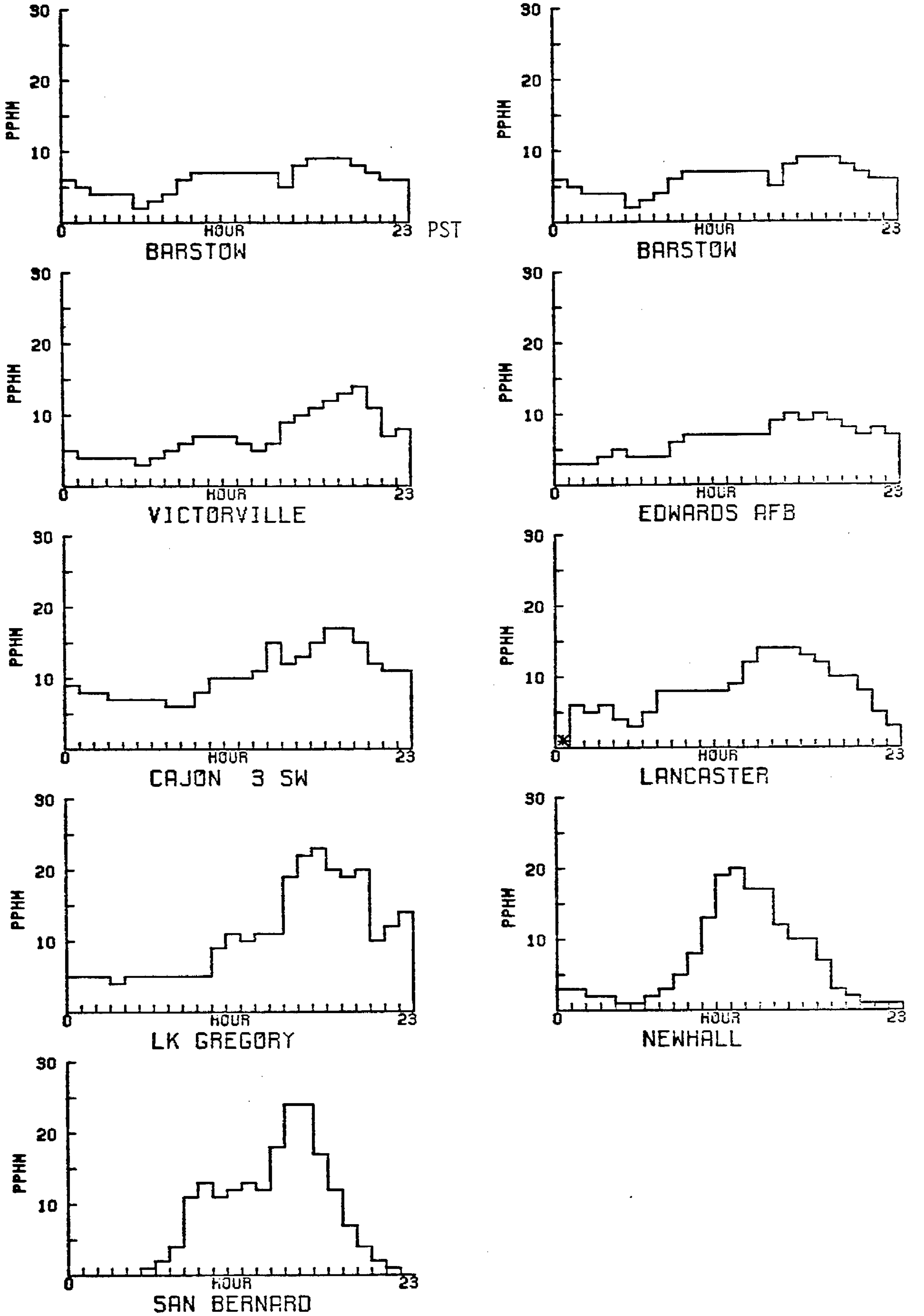
TIME OF MAXIMUM HOURLY OZONE CONCENTRATIONS - July 18,1981

Fig. 3.3.3



HOURLY OZONE CONCENTRATIONS - July 18,1981

Fig. 3.3.4



HOURLY OZONE CONCENTRATIONS - July 18,1981

Fig. 3.3.5

3.3.3 Aircraft Sampling - July 18-19, 1981

July 18

Aircraft sampling on July 18 was carried out primarily in the Mojave Desert near Victorville in support of the tracer release from Cajon Pass. A map of the flight pattern on July 18 is shown in Figure 3.3.6. A list of locations corresponding to designated points on the map is given in Table 3.3.6. More details on the various segments of the flight pattern are given in Table 3.3.7.

The first spiral of July 18 was made at Rialto Airport to document the vertical structure of pollutants in the basin. This spiral is shown in Figure 3.3.7. A pronounced ozone layer existed at Rialto to a level of 1300 m (msl). Peak ozone readings within this layer were about 25 pphm.

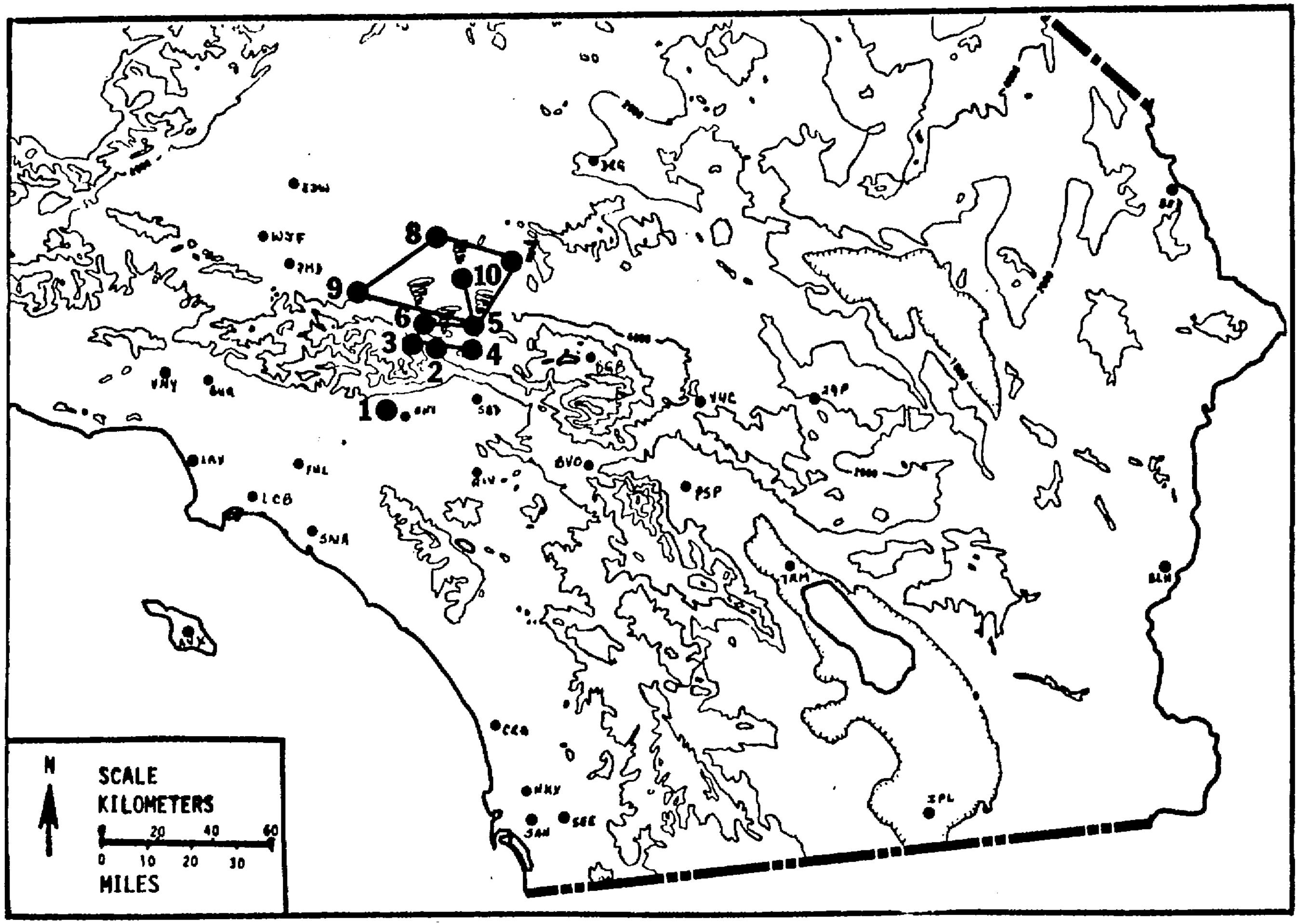
A sounding was then made at Cajon Junction at 1549 PDT (Figure 3.3.8). A shallow layer of ozone was present near the surface. Depth of the layer was about 600 m (top 1500 m msl). Ozone concentrations aloft were higher than at corresponding levels over Rialto, suggesting the transport of ozone from the southern slopes of the mountains. Winds aloft in this layer were from the southwest at Cajon Junction.

A horizontal traverse was flown at 1372 m (msl) beginning at 1613 PDT. The traverse was flown across Cajon Pass and over Cajon Junction near the top of the surface ozone layer. Figure 3.3.9 shows the results of this traverse. Ozone concentrations were clearly higher on the edges of the pass than in the center. The surface ozone concentration at 16 PDT at Cajon was 12 pphm. It is suggested that the aircraft was above the surface layer in the central part of the valley and that the surface layer extended to a greater height on each side of the valley.

A sounding was made at Hesperia Airport at 1622 PDT (Figure 3.3.10). The structure of the sounding was similar to that observed at Cajon Junction (Figure 3.3.8). A low-level ozone layer was present at the airport with a top of 1700 m (msl), slightly higher than at Cajon Junction. The elevated ozone layer, representing the effects of mountain slopes, was also present at Hesperia at about the same elevation.

Figure 3.3.11 shows a sounding made at Pt. 6 a few km to the west of Cajon Pass and over Pearblossom highway. The surface layer of ozone was present to a height of 2100 m (msl) with the same ozone layer aloft between 2100 m and 3000 m (msl). In comparison with the Cajon and Hesperia soundings, the relatively clean layer between the upper and lower layers is not present in Figure 3.3.11.

A series of horizontal traverses were then undertaken by the aircraft as shown in Figure 3.3.6. The flight level was at 1372 m (msl) for all of the traverses which represents a height of about 400-500 m over the terrain on most of the legs. The traverses were intended to map out the horizontal distribution of ozone aloft in the area surrounding Victorville and across the exit of Cajon Pass. Figures 3.3.12 to 3.3.17 cover the results of these traverses.



MRI SAMPLING FLIGHT - July 18,1981

Fig. 3.3.6

Table 3.3.6
18 July Tape #254
TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	$34^{o}07.5'$	$117^{o}23'$	Rialto Airport
2	$34^{o}18.8'$	$117^{o}28.5'$	Cajon Junction
3	$34^{o}18.5'$	$117^{o}31.0'$	West side of Cajon Pass
4	$34^{o}18.0'$	$117^{o}20.2'$	Silverwood Lake
5	$34^{o}22.5'$	$117^{o}18.5'$	Hesperia Airport
6	$34^{o}22.0'$	$117^{o}33.0'$	West of Cajon Pass over Pear Blossom Hwy.
7	$34^{o}35.0'$	$117^{o}11.0'$	Apple Valley Airport
8	$34^{o}46.0'$	$117^{o}29.5'$	Sun Hill Ranch
9	$34^{o}30.0'$	$117^{o}46.0'$	East of Llano
10	$34^{o}31.2'$	$117^{o}18.8'$	Victorville Drive-In

MRI FLIGHT SUMMARY

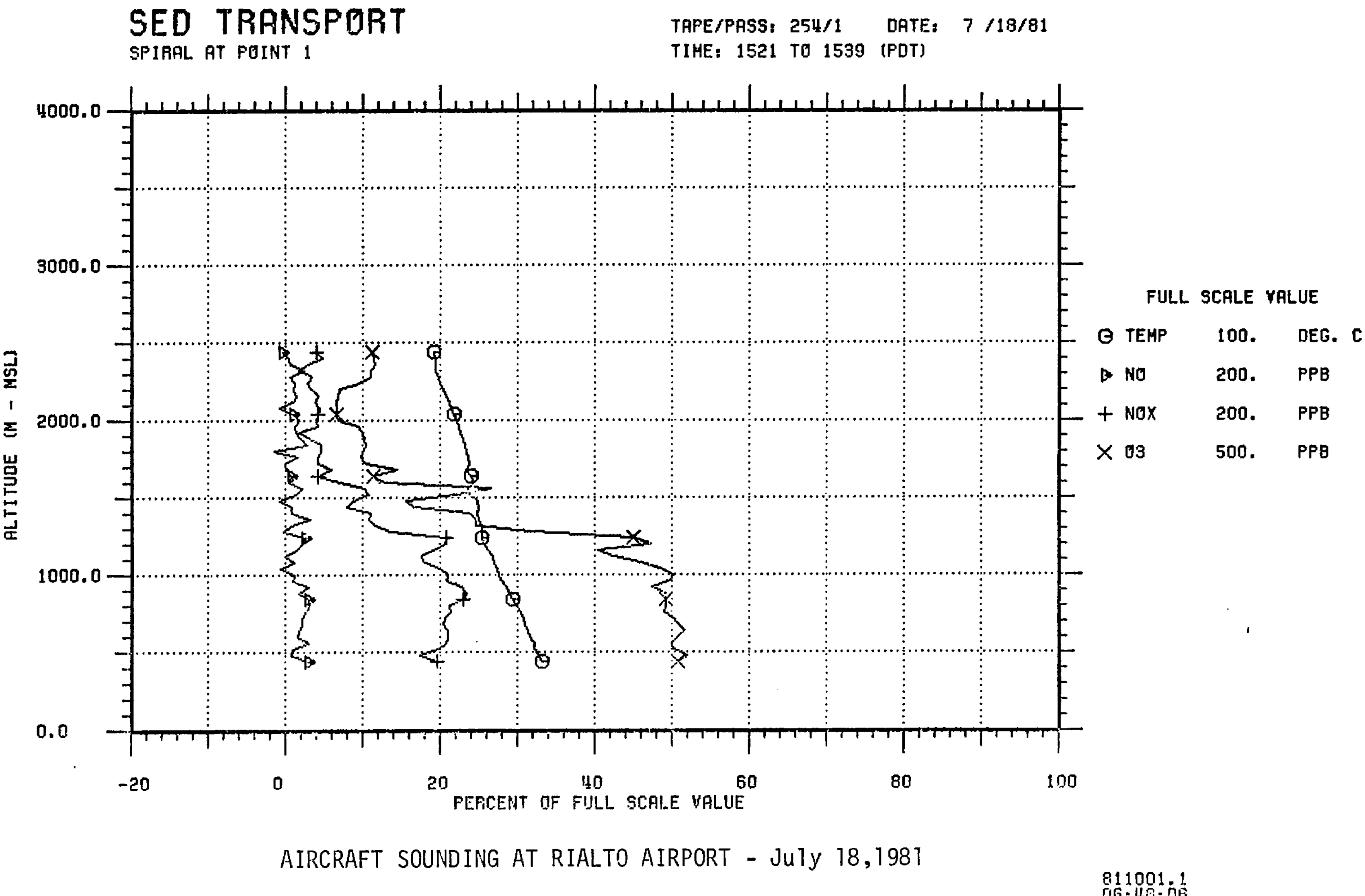
Date: July 18, 1981

SOUTHEAST DESERT OZONE TRANSPORT STUDY

Tape #: 254

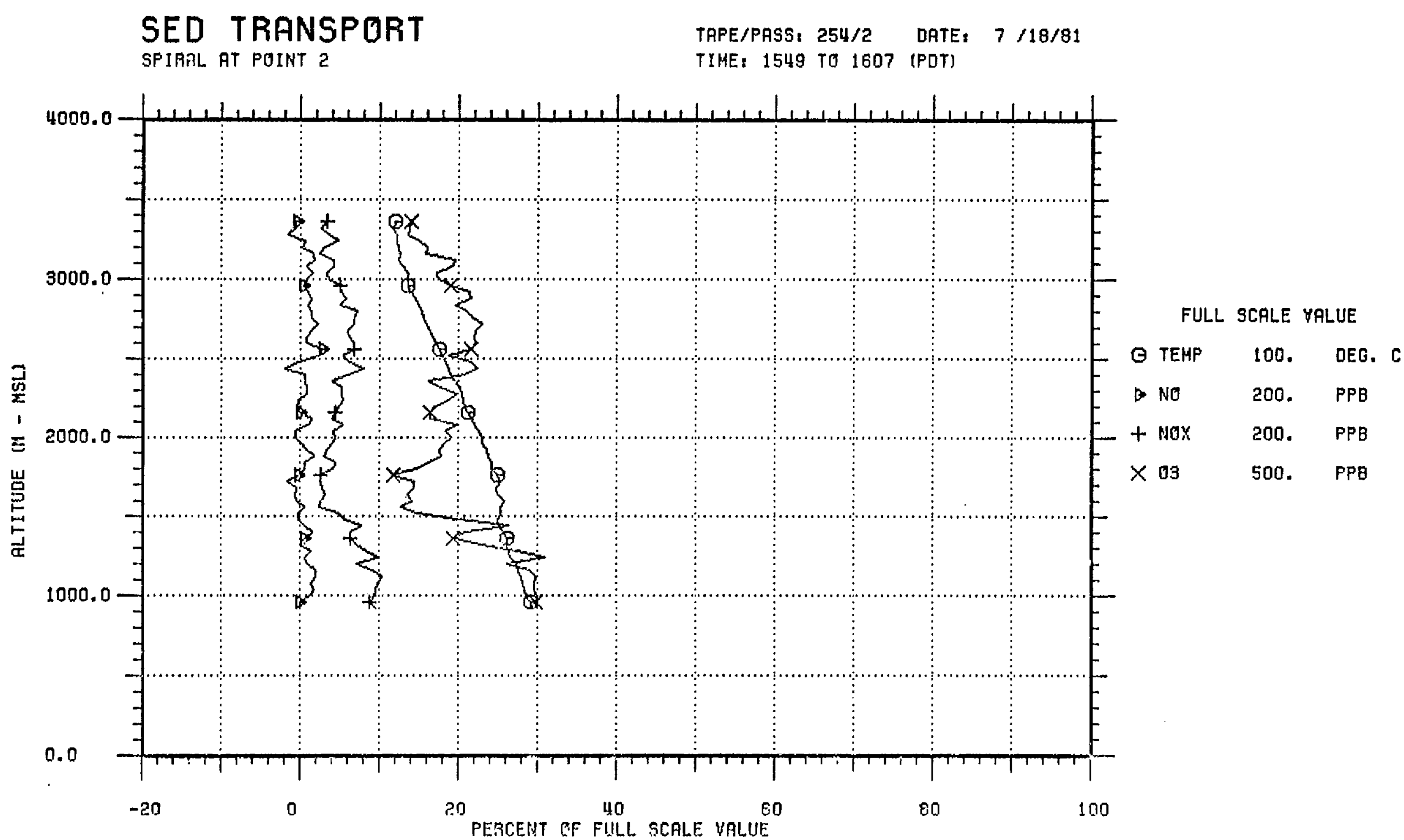
Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start – End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1521	1539	Spiral	1	442-2438	N.A.	D1-14	Sfc Elev = 437 m
2	1549	1607	Spiral	2	3353- 914	N.A.	D15-31	Sfc Elev = 890 m
3	1613	1619	Traverse	3 - 4	1372	16.7 Km.	D32-43	Across Cajon Pass
4	1622	1644	Spiral	5	1036-3353	N.A.	D44-60	Sfc Elev = 1034 m
5	1652	1705	Spiral	6	3353-1250	N.A.	D61-75	Sfc Elev = 1235 m
6	1707	1713	Traverse	6 - 5	1372	21.1 Km.	D76-83	
7	1718	1724	Traverse	5 - 7	1372	25.9 Km.	D84-90	
8	1725	1733	Traverse	7 - 8	1372	34.6 Km.	D91-99	
9	1737	1748	Traverse	8 - 9	1372	38.2 Km.	D100-111	
10	1750	1803	Traverse	9 - 5	1372	43.5 Km.	D112-126	El Mirage convergence zone
11	1805	1808	Traverse	5 - 10	1372	16.3 Km.	D127-130	
12	1810	1833	Spiral	10	945-3353	N.A.	D131-147	Sfc Elev = 915m
13	1339	1855	Zero Spiral		3353- 442	N.A.		Instrument calibration

Table 3.3.7



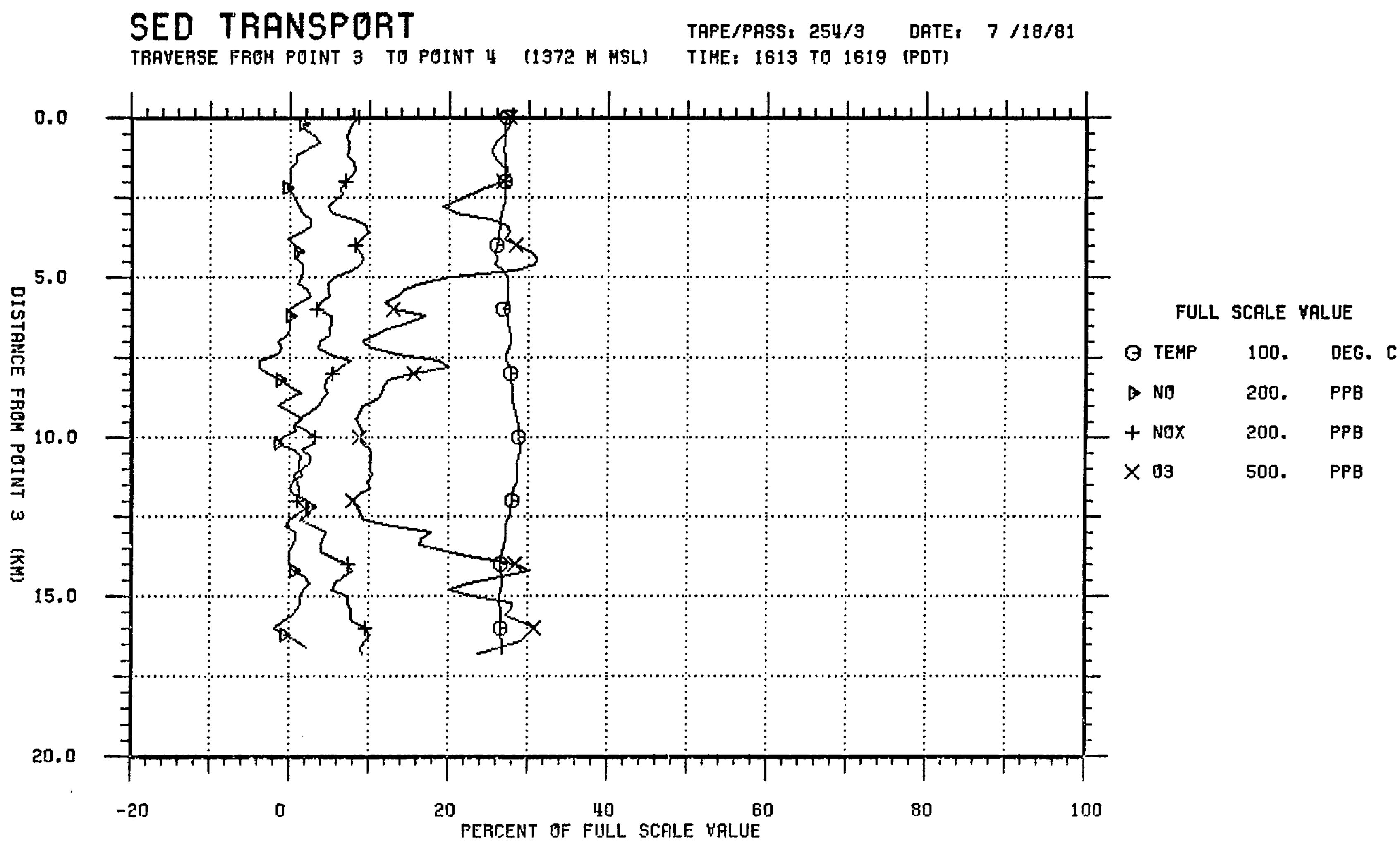
AIRCRAFT SOUNDING AT RIALTO AIRPORT - July 18,1981

Fig. 3.3.7



AIRCRAFT SOUNDING AT CAJON JUNCTION - July 18,1981

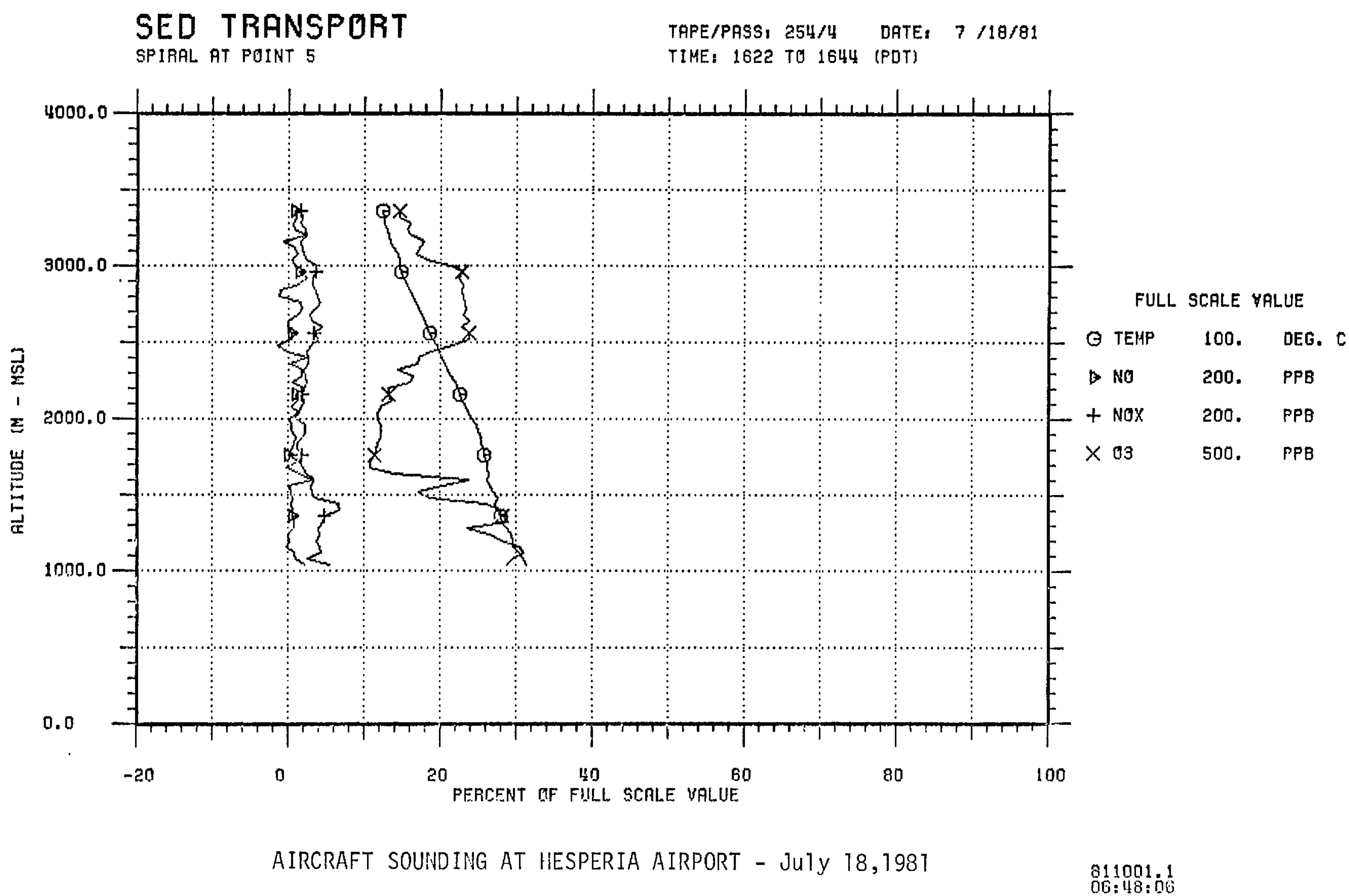
Fig. 3.3.8



AIRCRAFT TRAVERSE FROM W CAJON PASS TO SILVERWOOD LAKE - July 18,1981

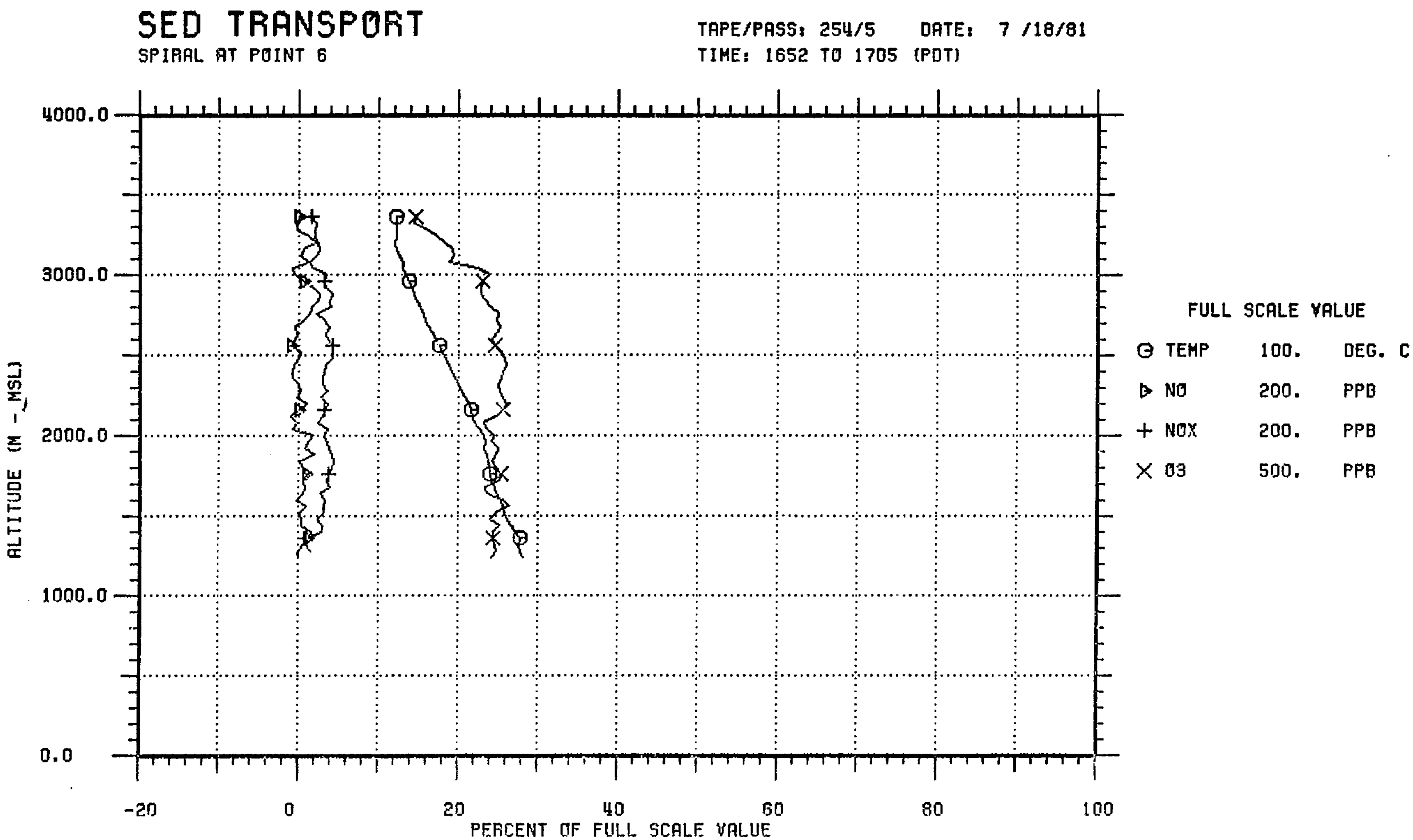
811001.1
06:48:06

Fig. 3.3.9



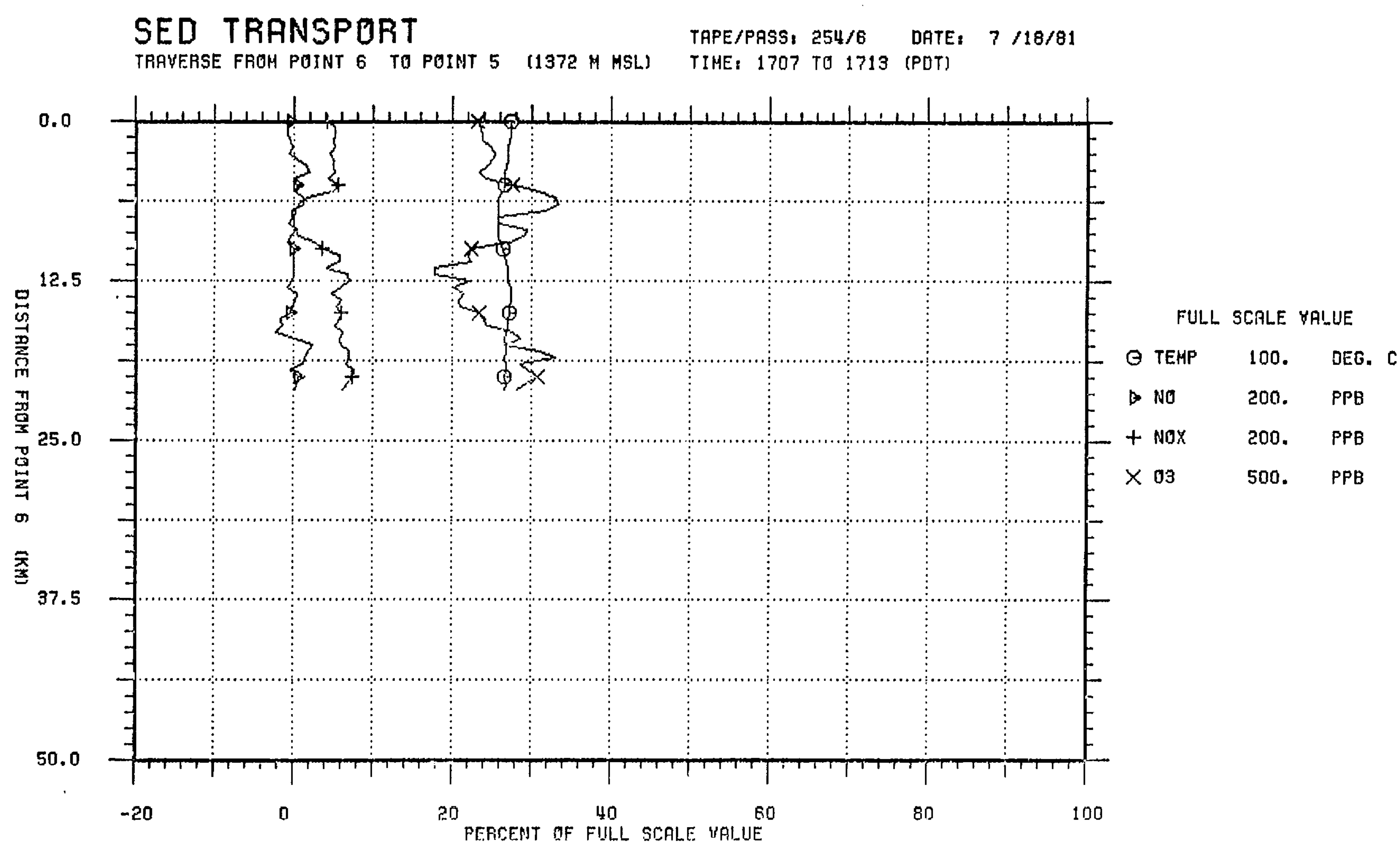
AIRCRAFT SOUNDING AT HESPERIA AIRPORT - July 18,1981

Fig. 3.3.10



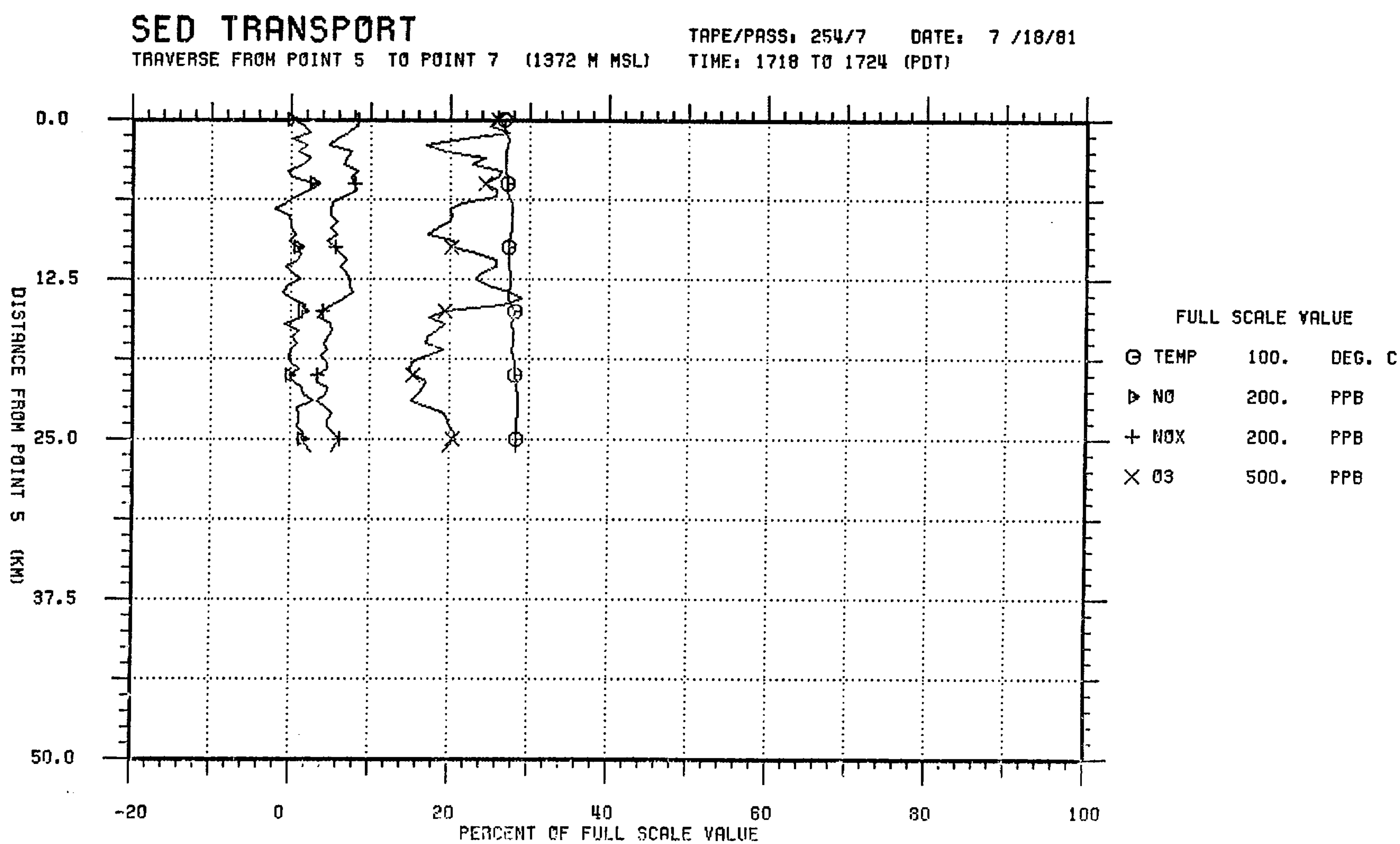
AIRCRAFT SOUNDING NW OF CAJON PASS - July 18,1981

Fig. 3.3.11



AIRCRAFT TRAVERSE FROM NW CAJON PASS TO HESPERIA AIRPORT - July 18,1981

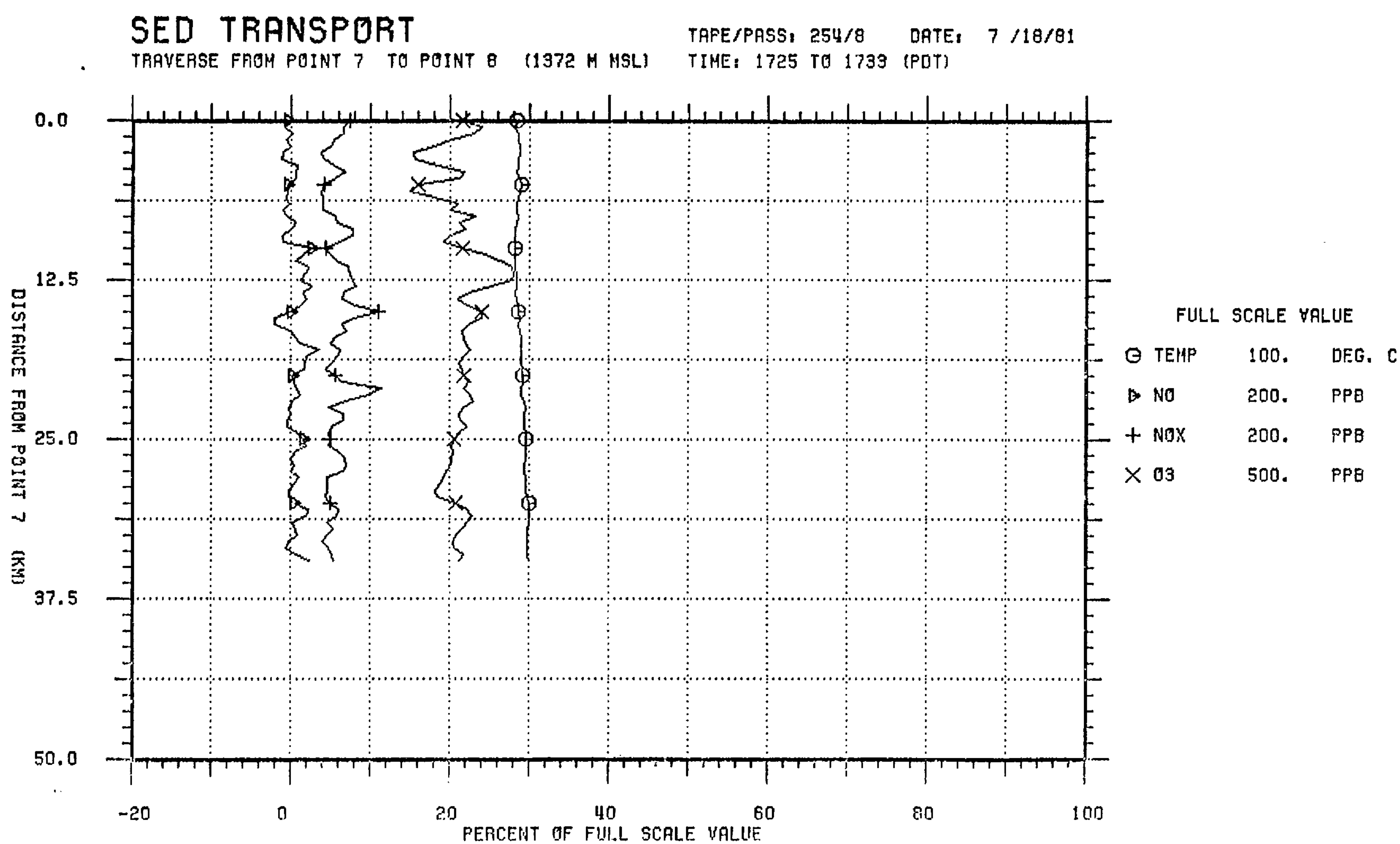
Fig. 3.3.12



AIRCRAFT TRAVERSE FROM HESPERIA AIRPORT TO APPLE VALLEY AIRPORT - July 18,1981

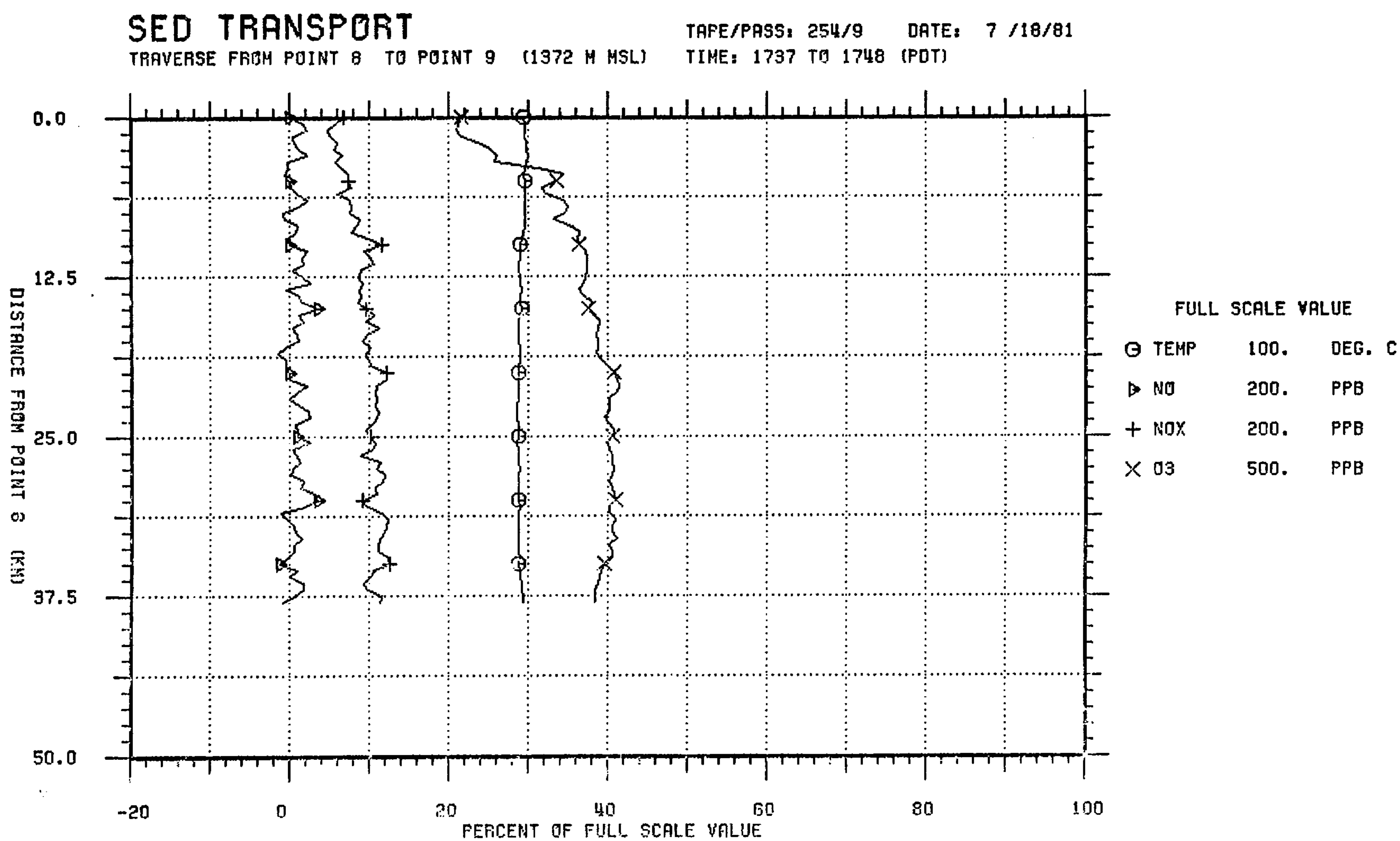
811001.1
06:48:06

Fig. 3.3.13



AIRCRAFT TRAVERSE FROM APPLE VALLEY AIRPORT TO SUN HILL RANCH - July 18,1981

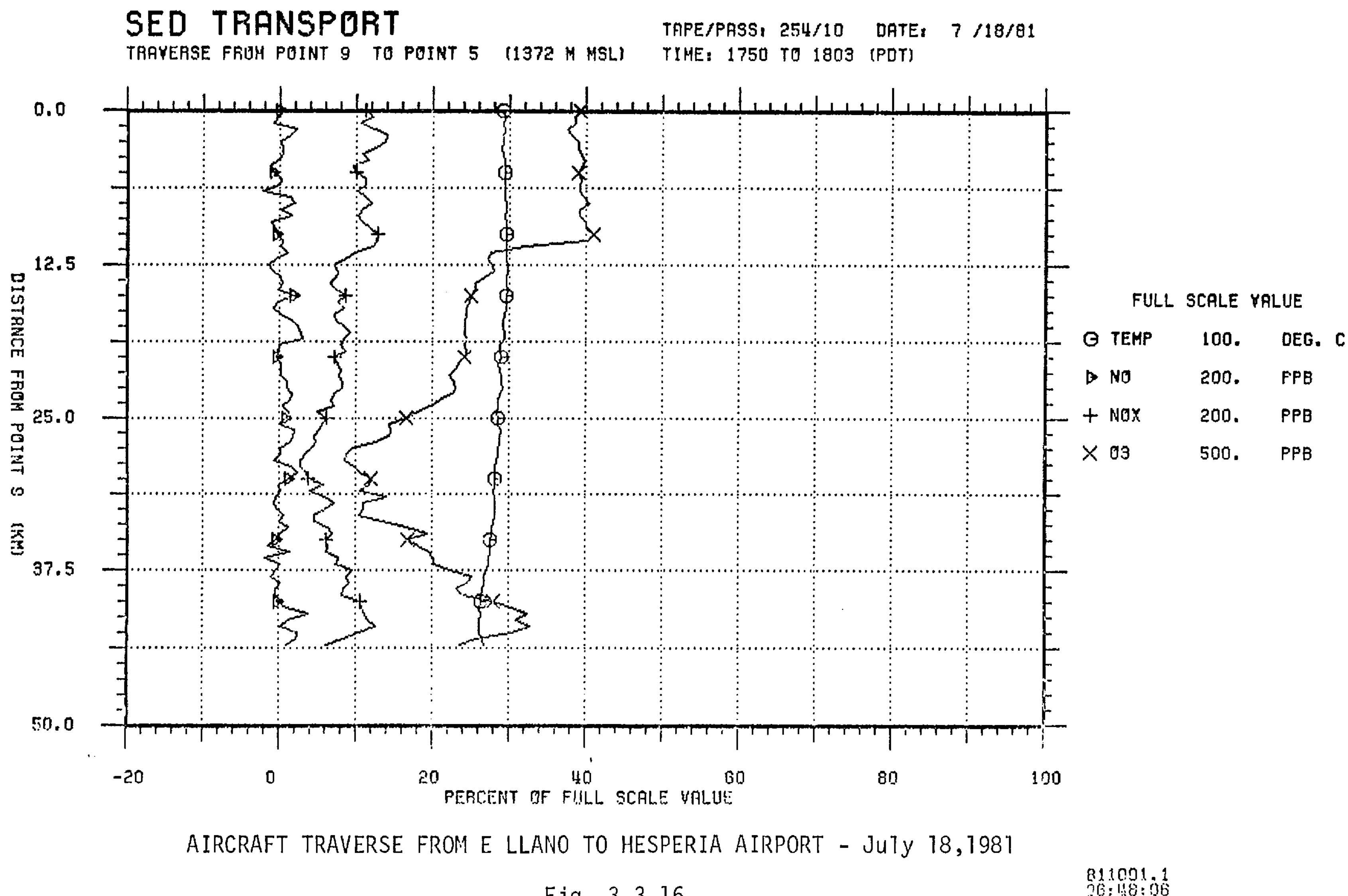
Fig. 3.3.14



AIRCRAFT TRAVERSE FROM SUN HILL RANCH TO E LLANO - July 18,1981

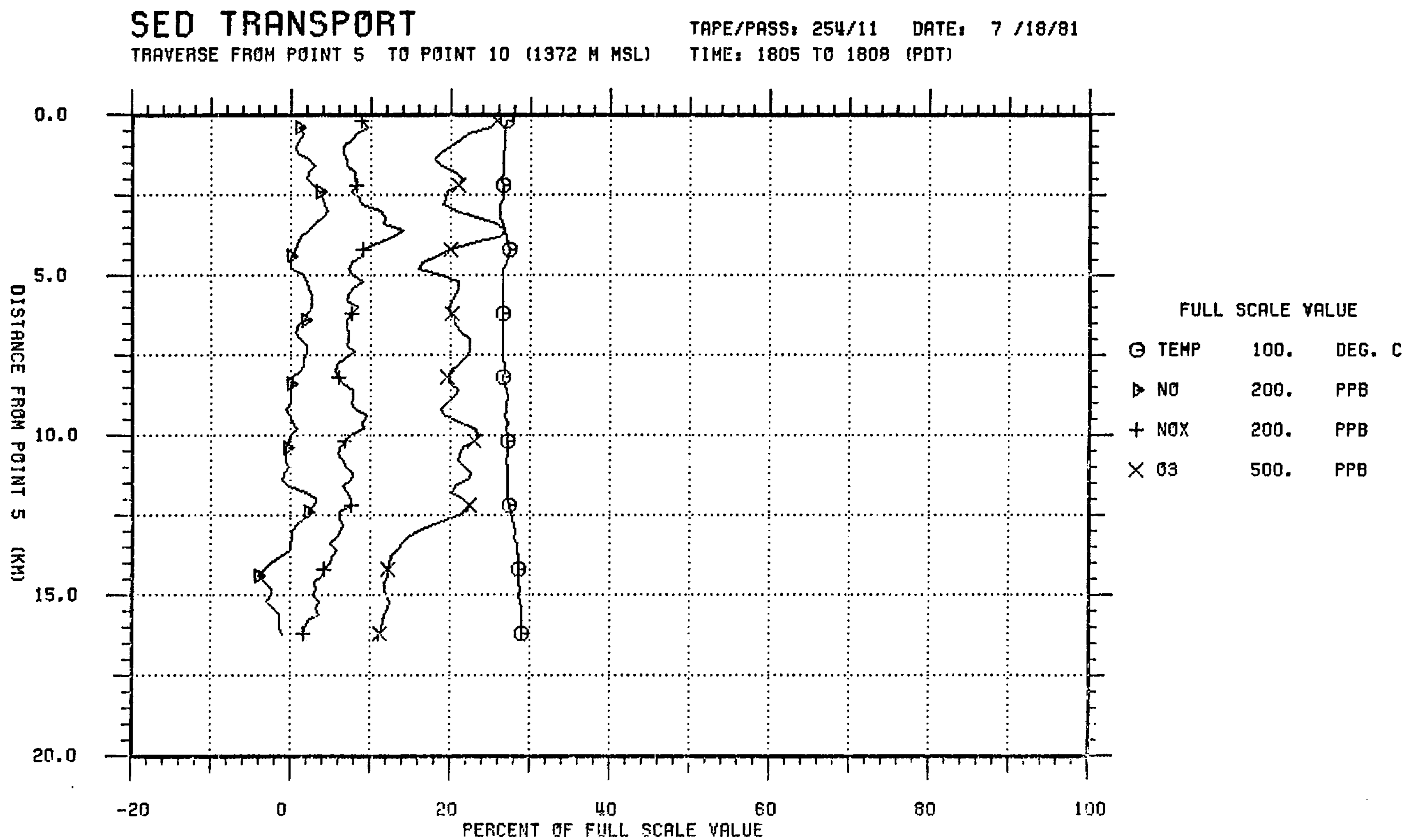
Fig. 3.3.15

811001.1
06:48:06



AIRCRAFT TRAVERSE FROM E LLANO TO HESPERIA AIRPORT - July 18,1981

Fig. 3.3.16



AIRCRAFT TRAVERSE FROM HESPERIA AIRPORT TO VICTORVILLE - July 18,1981

811001.1
06:40:06

Fig. 3.3.17

The traverse across the exit of Cajon Pass (Figure 3.3.12) shows generally lower ozone concentrations near the center of the pass. Again, this may be due to differences in height of the top of the surface layer as was the case in Cajon Pass itself.

Ozone concentrations along traverses from Pts. 5 to 7 and from 7 to 8 (see Figure 3.3.6) averaged 10-12 pphm with the highest concentrations near Hesperia. As indicated in Figure 3.3.15, after leaving Pt. 8 (Sun Hill Ranch to the northwest of Victorville) an abrupt increase in the ozone concentration at flight level was observed with the values becoming quite uniform at about 20 pphm. This uniform concentration continued for about 10 km past Pt. 9 on the return leg to Hesperia Airport (Figure 3.3.16). An abrupt decrease in ozone then occurred, increasing again near the exit from Cajon Pass.

A final traverse from Hesperia Airport to Victorville (Figure 3.3.17) at 1805 PDT showed average ozone concentrations of about 10 pphm.

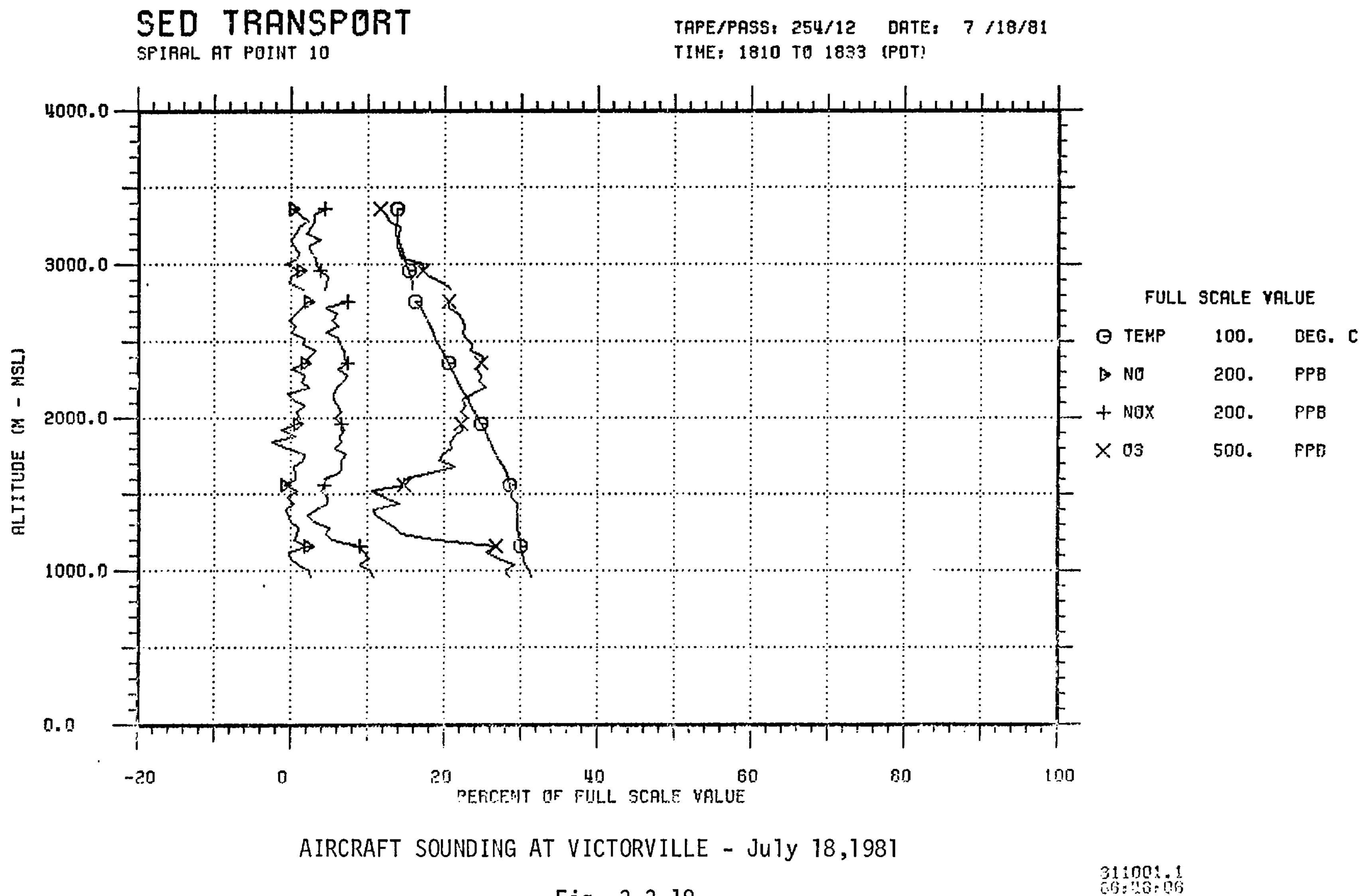
It is suggested that the abrupt change in ozone concentrations was associated with the El Mirage convergence zone with high ozone concentrations from the west behind the zone. The maximum ozone concentration observed at Victorville on July 18 was 14 pphm at 21 PDT. Surface winds at Victorville shifted from southerly to southwesterly at 19 PDT. It appears possible that the peak concentration at Victorville occurred after the passage of the convergence zone.

A final sounding was made at Victorville at 1810 PDT (Figure 3.3.18). The sounding structure shows a surface ozone layer about 200 m deep with a higher concentration layer aloft. The structure was similar to those observed earlier in the flight. The peak concentration aloft of about 11 pphm suggests that the higher ozone concentrations to the west had not yet arrived. Note that low-level stability had begun to be established by 18 PDT in conjunction with the beginning of nocturnal cooling.

<u>July 19</u>

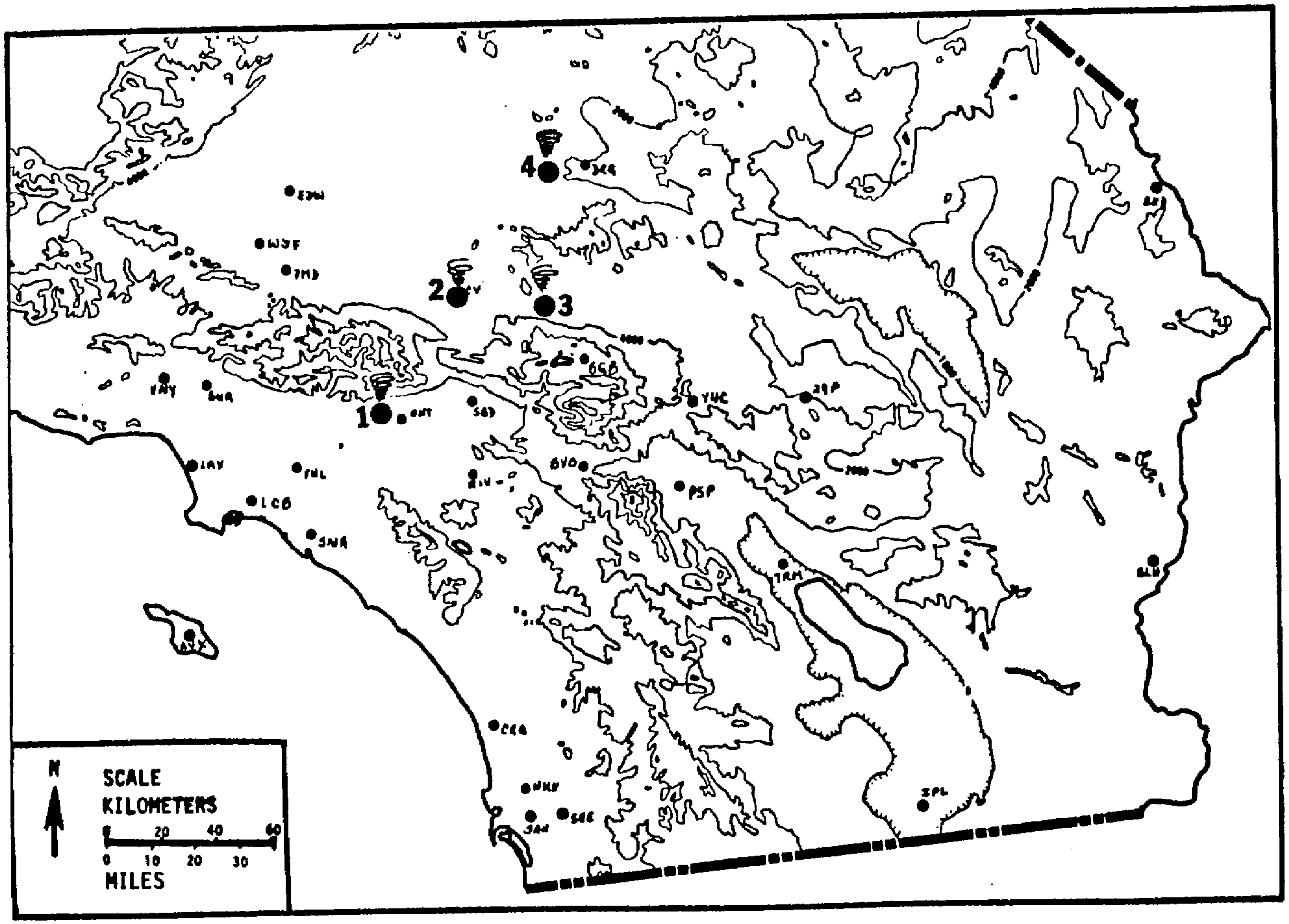
An early morning flight was carried out on July 19 to determine whether any significant carry over of pollutants from the previous day was present in the eastern portion of the Mojave Desert. Locations of the soundings made on July 19 are shown in Figure 3.3.19 and described in Table 3.3.8. Table 3.3.9 gives further details on the flight pattern.

The first sounding on July 19 was made at Cable Airport at 0657 PDT (Figure 3.3.20) to examine the vertical structure of the pollutants in the basin. A strong ozone layer was present over the airport betwen 800 and 1200 m (msl) with peak concentrations of about 15 pphm. A sharp NO peak was observed in the low levels, presumably from a local source, which contributed to the reduction in ozone levels in the low levels.



AIRCRAFT SOUNDING AT VICTORVILLE - July 18,1981

Fig. 3.3.18



MRI SAMPLING FLIGHT - July 19,1981

Fig. 3.3.19

Table 3.3.8

19 July 1981 Tape #255

TRAVERSE END POINT AND SPIRAL LOCATIONS

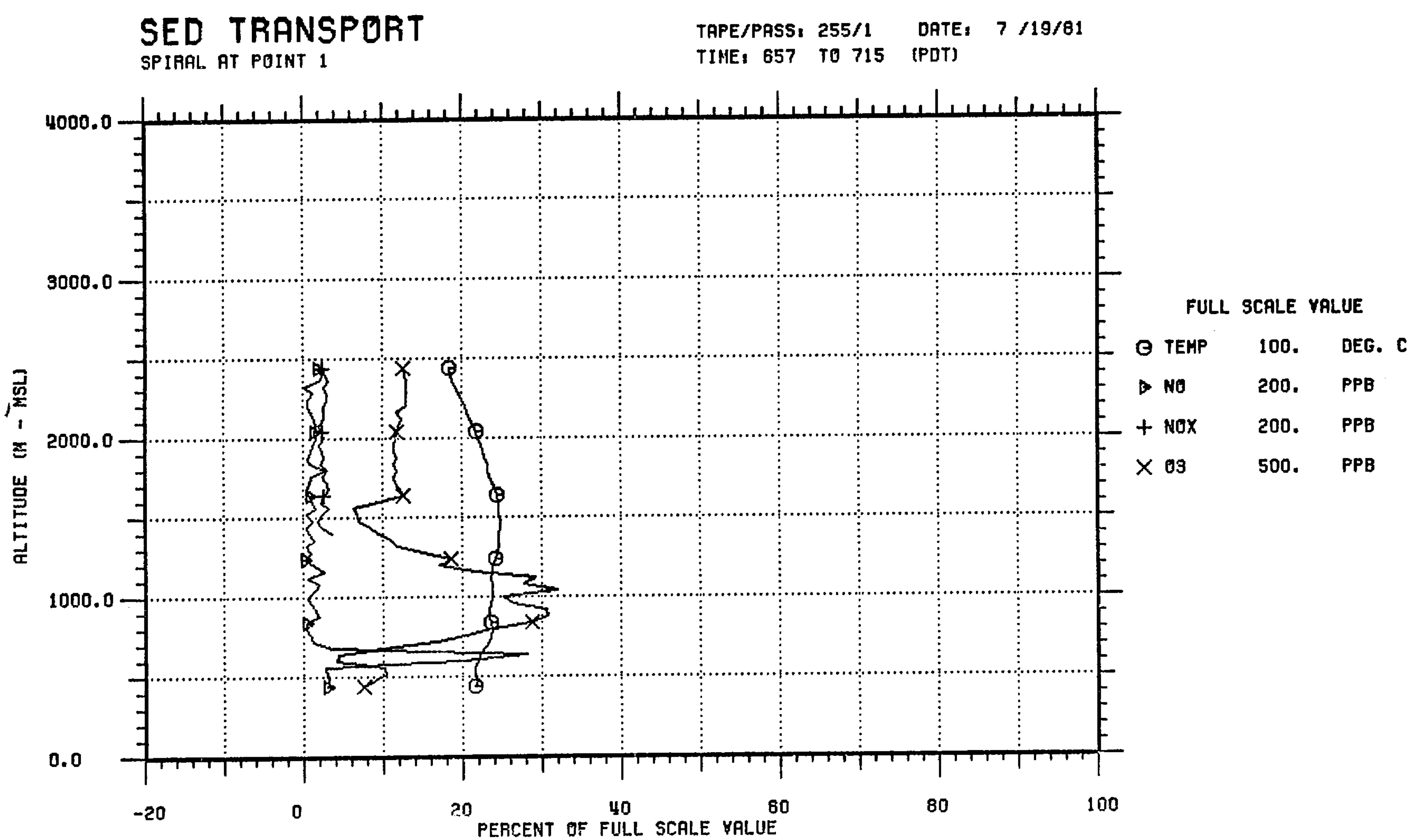
POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°06.0'	117°37.3'	Cable Airport
2	34°31.2'	117°18.8'	Victorville Drive-In
3	34°28.3'	117°01.0'	Rabbit Dry Lake Lucern Valley
4	34°54.3'	117°03.0'	Barstow

MRI FLIGHT SUMMARY

Date: July 19, 1981 SOUTHEAST DESERT OZONE TRANSPORT STUDY Tape #: 255

Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start-End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	657	715	Spiral	1	442-2438	N.A.	E1-14	Sfc Elev = 442 m
2	732	748	Spiral	2	3048- 922	N.A.	E15-29	Sfc Elev = 915 m
3	759	814	Spiral	3	853-2591	N.A.	E30-41	Sfc Elev = 849 m
4	827	844	Spiral	4	3048- 640	N.A.	E42-57	Sfc Elev = 634 m
5	910	925	Zero Spiral		2438- 442	N.A.	0	Instrument calibration

Table 3.3.9



AIRCRAFT SOUNDING AT CABLE AIRPORT - July 19,1981

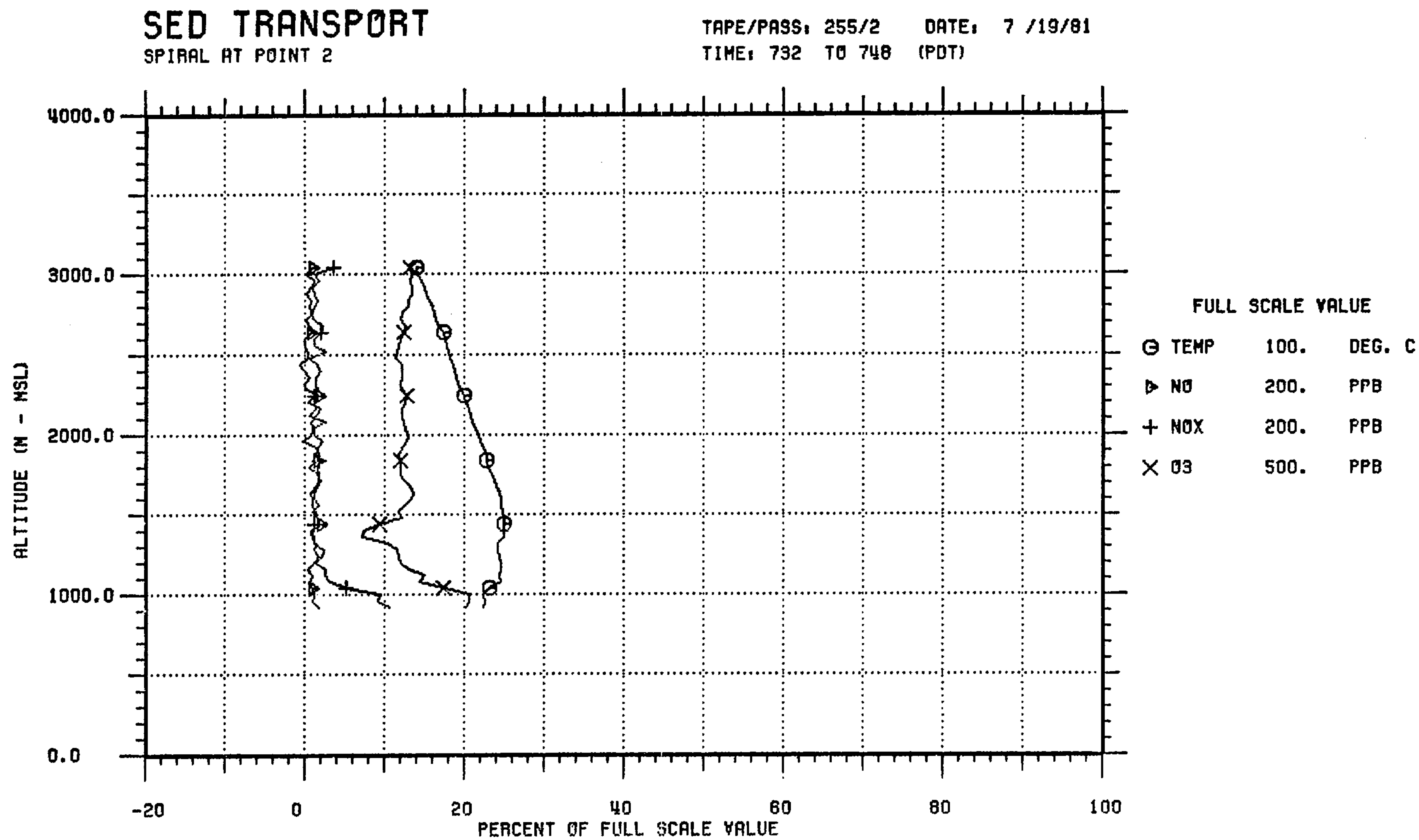
Fig. 3.3.20

800925.1
14:05:43

The next sounding (Figure 3.3.21) was made at Victorville at the same location as Figure 3.3.18. Ozone concentrations aloft were substantially reduced to expected ambient levels compared to the previous evening's sounding. Near the surface there was a shallow ozone layer with a peak concentration of 10 pphm. The surface ozone concentration at Victorville at 07 PDT was 4 pphm. These pollutants in the low layers may have been left over from the previous day's regime or could have been locally generated during the night. Aloft there appeared to be little carry over from the previous day.

Figure 3.3.22 shows a sounding at Lucerne Valley at 0759 PDT on July 19. A low-level layer of increased ozone concentrations existed to a height of about 700 m above ground. Peak ozone concentration in the layer was 10 pphm which was also the surface concentration measured at Lucerne Valley at 08 PDT. Since there are no major, local NO_x ozone sources in the valley, it has to be assumed that the increased ozone concentrations in the lowest 700 m represent pollutants brought in during the previous day which remained overnight.

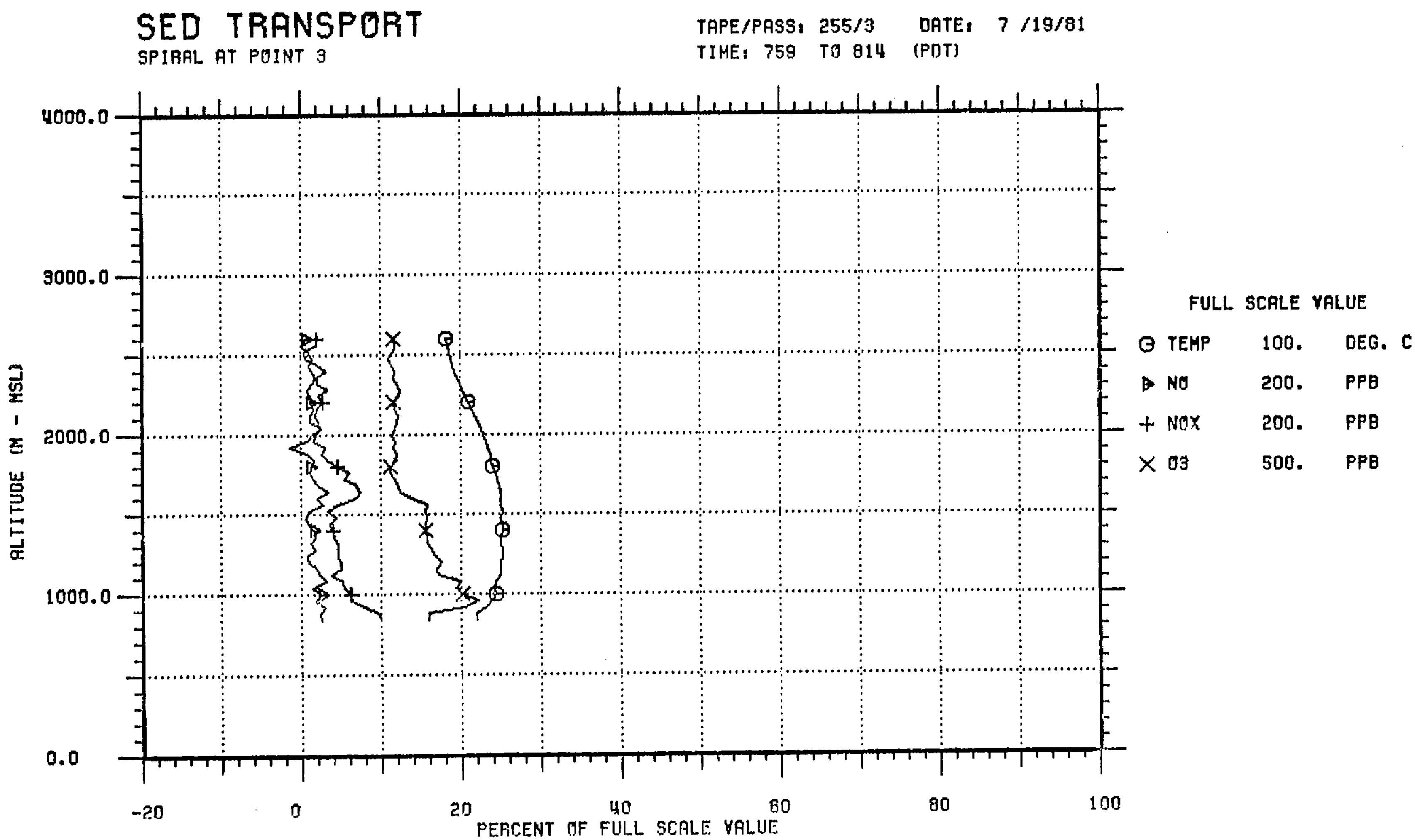
Figure 3.3.23 shows a sounding made at Barstow at 0827 PDT. A low-level layer of ozone was present to a height of about 700 m above ground. Aloft ozone concentrations were near background, ambient levels. Peak ozone concentration within the low layer was near 10 pphm. The surface ozone concentration at Barstow at 08 PDT was 5 pphm. Due to presence of some local sources in the area, primarily highway traffic, it is not possible to say whether the pollutants in the low layer at Barstow represented carry over or were local inputs during the night. Above the surface layer there was no indication of carry over from the previous day.



AIRCRAFT SOUNDING AT VICTORVILLE - July 19,1981

800925.1
14:05:43

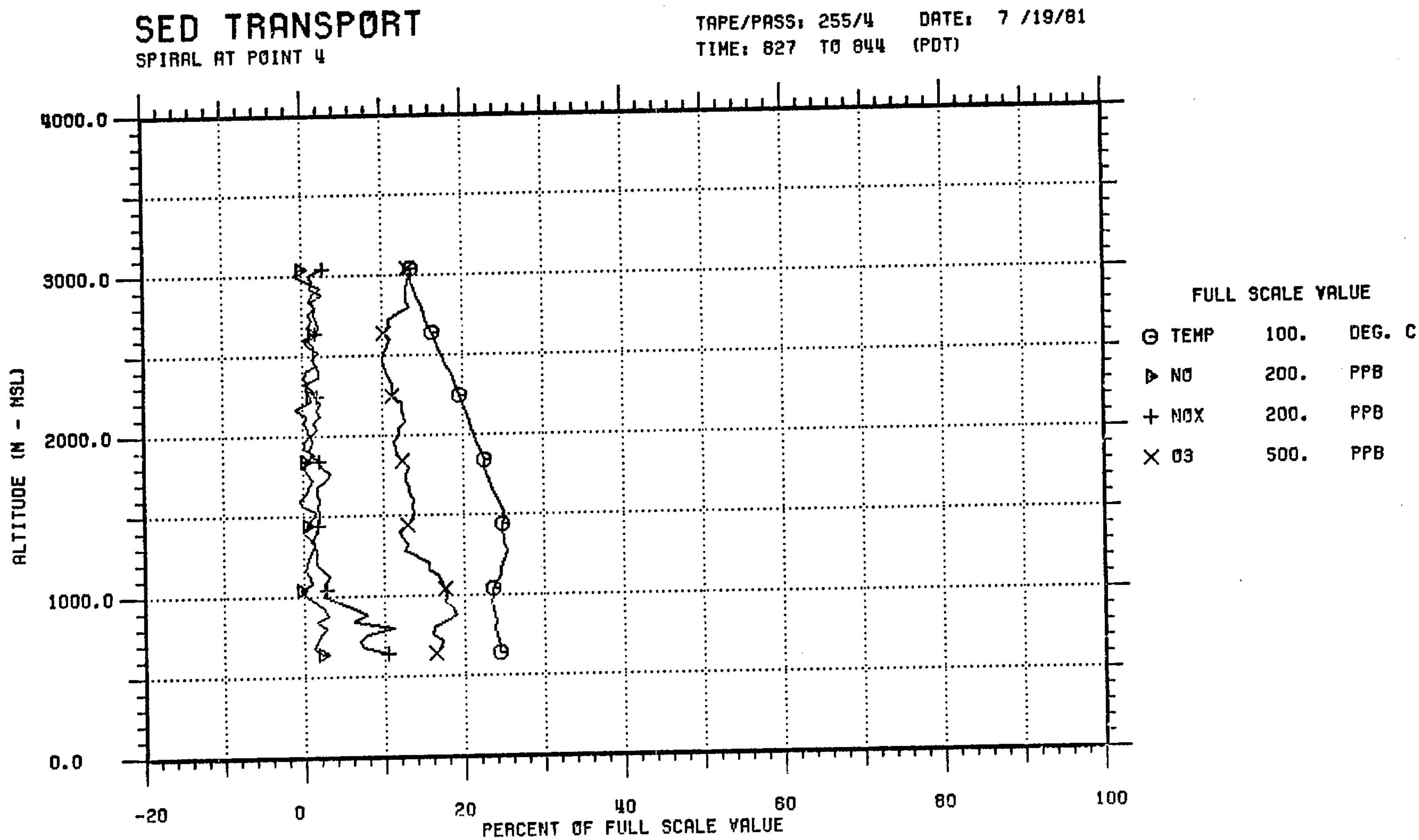
Fig. 3.3.21



AIRCRAFT SOUNDING AT LUCERNE VALLEY - July 19,1981

800925.1
14:05:43

Fig. 3.3.22



AIRCRAFT SOUNDING AT BARSTOW - July 19,1981

Fig. 3.3.23

800925.1
14:05:43

3.3.4 Tracer Results - Test 3

Release Location: Cajon Junction
Date: July 18, 1981
Time: 1300-1700 PDT
Release Rate: 9.3 g/sec SF_6

Surface winds at Cajon Junction during and after the release period were southeasterly with moderately strong velocities. Due to the terrain orientation in the pass this direction represents surface wind flow from the Los Angeles basin into the desert.

Figs. 3.3.24 and 3.3.25 are streamline charts for 14 and 18 PDT on July 18, respectively. These charts show that flow from the basin into the desert through Cajon Pass and San Gorgonio Pass was established by 14 PDT, continuing through 18 PDT. The significant difference in flow for the two time periods was a shift in wind direction in Lucerne Valley to westerly by 18 PDT. This is in contrast to the conditions of Test 2 where the wind at Lucerne remained southeasterly until later in the day. Winds in the desert were moderate to strong at most locations (generally 15-25 mph).

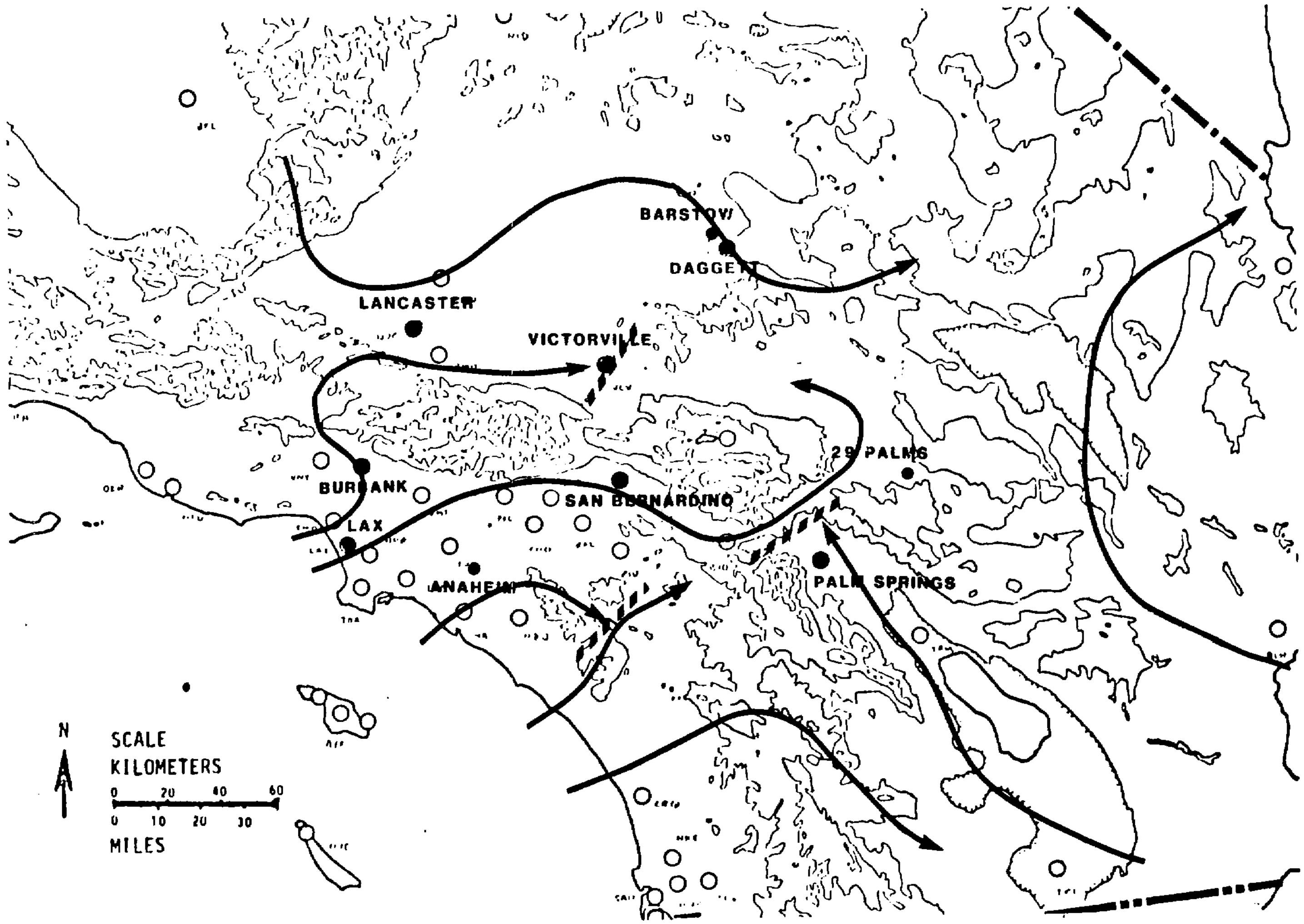
July 18

Fig. 3.3.26 shows the observed tracer trajectories on July 18. During the early part of the sampling the tracer plume moved northwestward to the west of Victorville. The trajectory then curved to the northeast, reaching the Barstow/Daggett area around 22 PDT.

By 16 PDT the wind direction at Victorville had shifted to the southwest and the portion of tracer plume released later moved to the east of Victorville into Lucerne Valley. A small concentration of tracer (14 ppt) was observed at the Lucerne Valley sampler at 20 PDT.

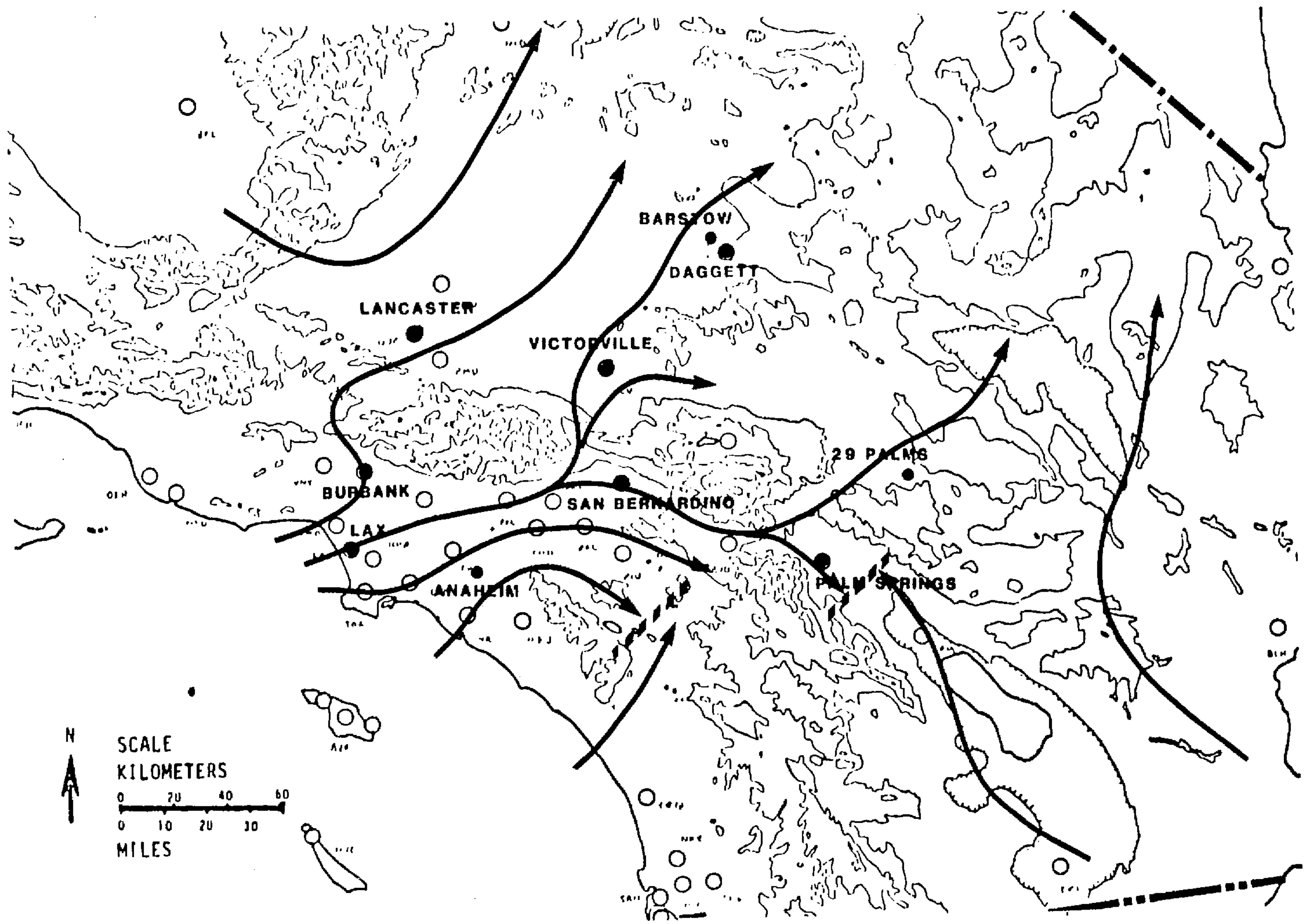
The primary impact of the tracer material was observed to the west of Victorville about 16-17 PDT where concentrations over 250 ppt were found. Impacts at Barstow/Daggett and in Lucerne Valley were relatively small, of the order of 10-20 ppt.

An aircraft spiral was made at Victorville at 1810 PDT. Tracer samples obtained during the spiral show SF_6 concentrations to 51 ppt in a deep layer from 4100 ft. to 9100 ft msl. The base of the layer was approximately 1000 ft. above the terrain in the Victorville area.



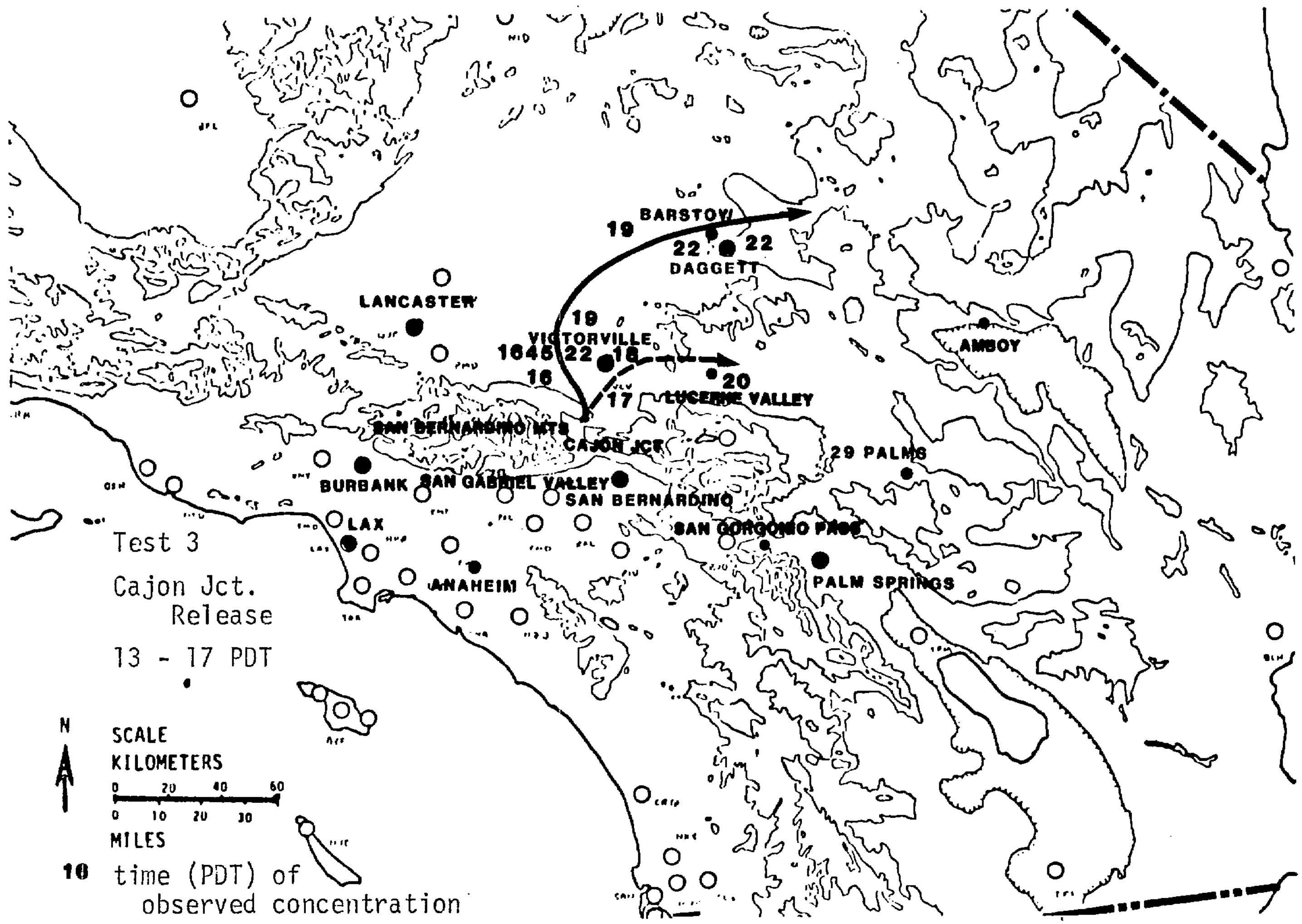
STREAMLINE MAP (14 PDT) - July 18,1981

Fig. 3.3.24



STREAMLINE MAP (18 PDT) - July 18,1981

Fig. 3.3.25



TRACER TRAJECTORIES - July 18,1981

Fig. 3.3.26

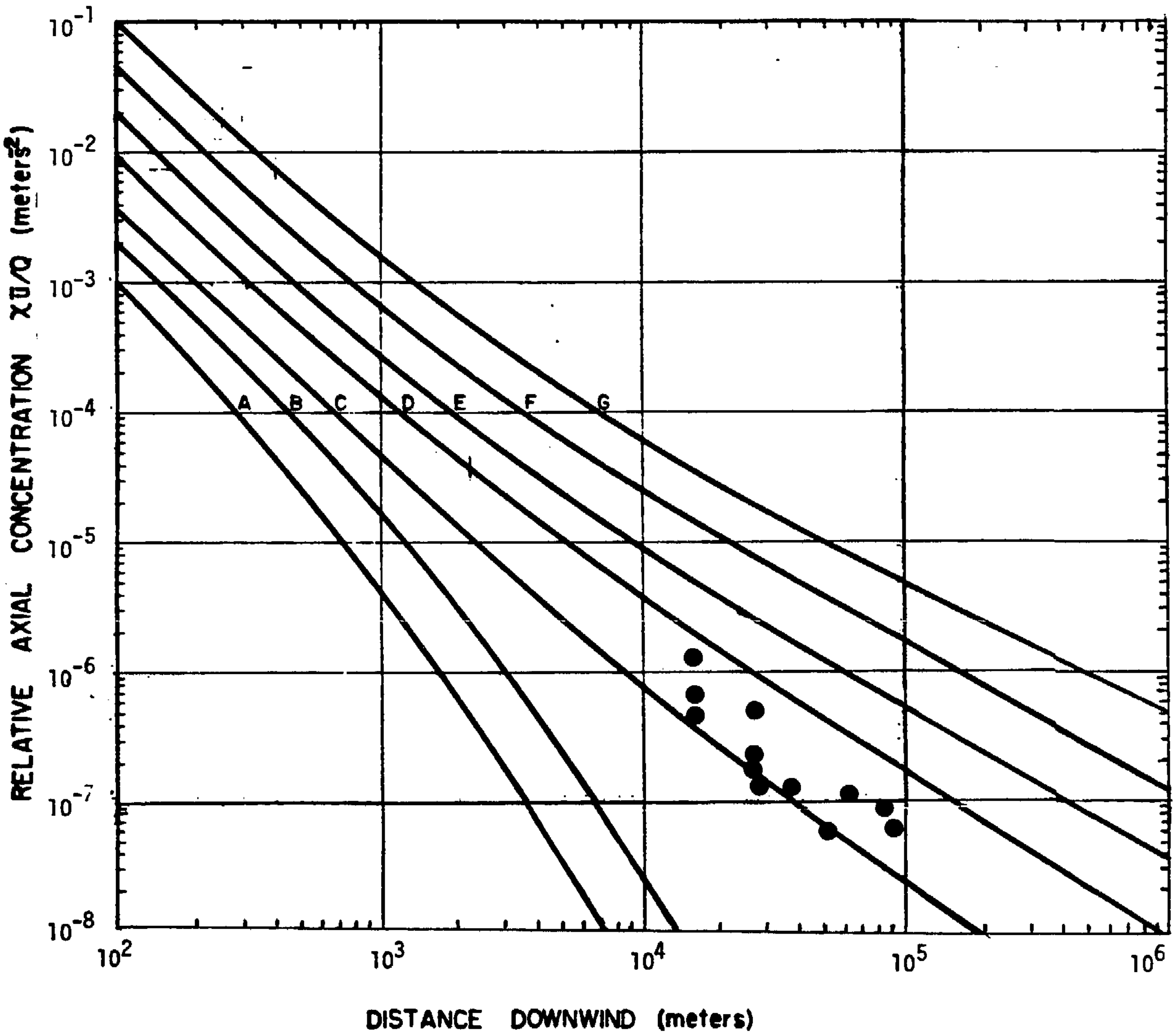
Fig. 3.3.27 gives the Xu/Q values for Test 3 as calculated from the average wind speed at Cajon Junction during the release period (average velocity of 6.9 m/s). The Xu/Q values all fall in the C-D stability category.

July 19

Automobile traverses on July 19 extensively explored the Mojave Desert and the Coachella Valley in search of evidence for carry-over from the previous day. The area covered extended from Amboy to 29 Palms to Calipatria and westward to Barstow and Victorville. Scattered concentrations of less than 20 ppt were found sporadically in the desert areas but there was no coherent pattern apparent. A peak concentration of 22 ppt was found in the San Bernardino Mts. together with scattered concentrations of lower magnitudes.

In view of the low concentrations observed late in the evening on July 18 and the moderately strong wind flow in the area, little carry-over should be anticipated into the morning of the 19th.

There was no indication of unusual amounts of tracer material in the San Gabriel Valley on the day after release as were found in Tests 1 and 2.



CALCULATED XU/Q VALUES - Test 3

July 18,1981

Fig. 3.3.27

3.4 Test 4 22-23 July 1981, South Fontana Release (1300-1700 PDT, 7/22/81)

3.4.1 Meteorology

General

A strong high pressure ridge aloft was present over Southern California for several days prior to July 22. By July 22 (Figure 3.4.1) the ridge had begun to break down but light, variable winds aloft still dominated the area. Surface pressures were unusually high to the west of Washington-Oregon.

Table 3.4.1 gives assorted meteorological parameters for July 22. The 850 mb temperature at Vandenberg AFB of 24°C was considerably above the July average of 20°C. Pressure gradients to the inland areas were quite high, reflecting the low level influx of marine air following a hot period (Ontario maximum temperature of 104° on July 20). Maximum surface temperature at Ontario had dropped to 96°F by July 22 but temperatures were still quite warm in the desert. The morning inversion base height at UCLA of 250 m is in the lowest one-third of the heights observed at LAX (Keith, 1980).

July 22 represents a potentially significant air quality day with low inversions, warm temperatures aloft and strong transport from the coastal areas into the desert.

Transport Winds

Surface winds at the Fontana release site on July 22 are given in Table 3.4.2:

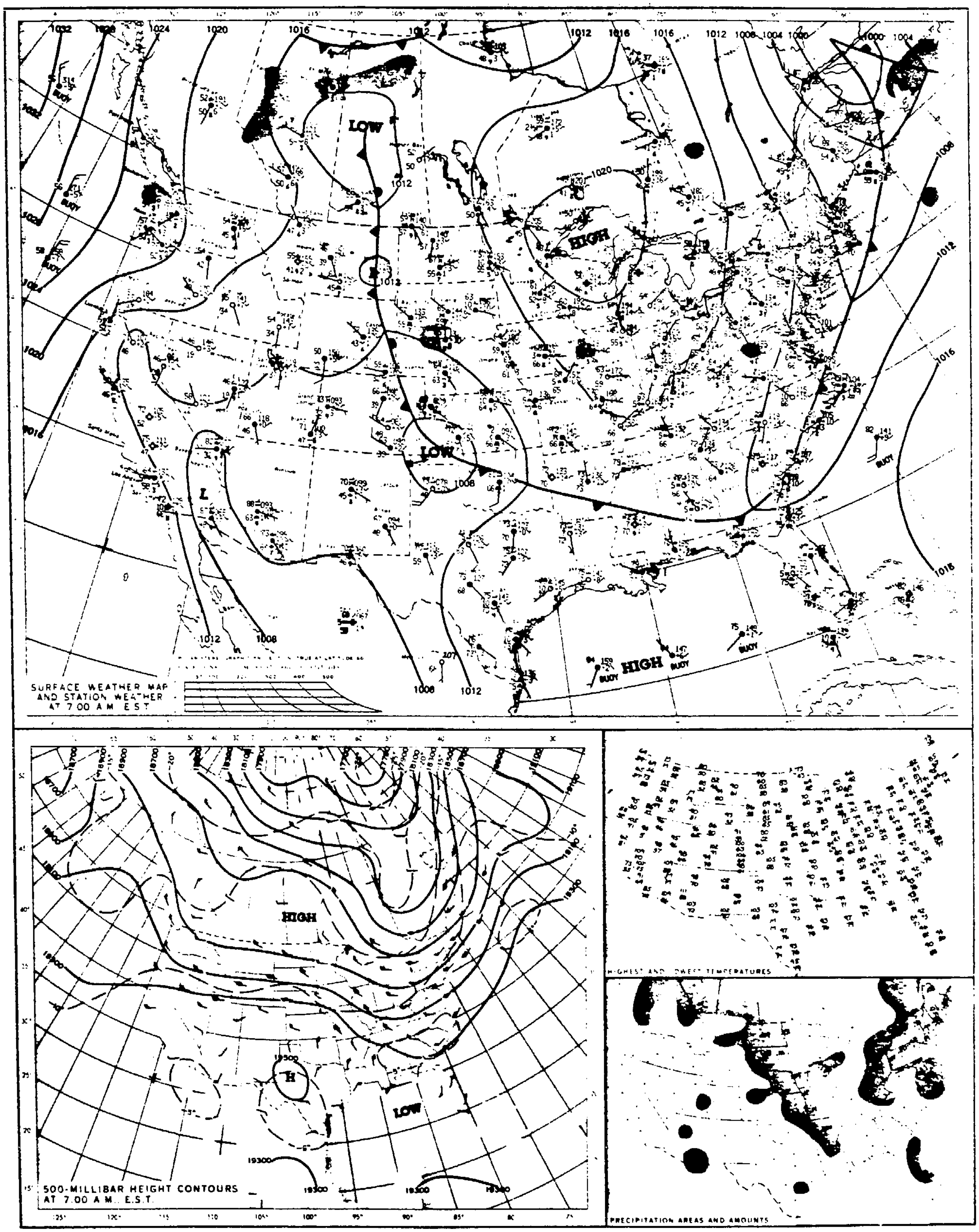
Table 3.4.2

SURFACE WINDS AT FONTANA DURING AND AFTER RELEASE

JULY 22, 1981

Time (PDT)	Direction (°)	Speed (m/s)
13	250	3.1
14	250	3.4
15	240	4.0
16	240	4.1
17	230	4.1
18	240	4.4
19	250	3.6
20	240	2.7

WEDNESDAY, JULY 22, 1981



WEATHER MAP

July 22,1981

Fig. 3.4.1

Table 3.4.1

METEOROLOGICAL PARAMETERS

JULY 22, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	24.0°C
Edwards AFB	(0430 PDT)	24.8
Ontario	(0830 PDT)	21.6
UCLA	(0600 PDT)	24.2
Pressure Gradients	(0800 PDT)	
LAX - Daggett		4.4 mb
LAX - Bakersfield		2.7
Maximum Surface Temperature		
Ontario		96°F (35.6°C)
Palm Springs		112 (44.4)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	21.0°C (250 m)
Rialto	(0700 PDT)	18.3 (Surface)
Ontario	(0830 PDT)	20.6 (480 m)
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	26.8°C (945 m)
Rialto	(0700 PDT)	24.4 (1050 m)
Ontario	(0830 PDT)	23.6 (1820 m)

* All heights are msl

Surface winds at Fontana during the release period (13-17 PDT) were from the west-southwest, reflecting a normal sea breeze flow in that area. Wind velocities peaked in the late afternoon but without any significant change in wind direction.

Surface winds at Lancaster, Victorville and Palm Springs are given in Table 3.4.3 for July 22 and 23. Winds at Lancaster were consistently from the west-southwest for the entire period with velocities of 5 m/s or more. These velocities reflect the moderately strong onshore pressure gradients existing on July 22 and 23.

At Victorville the flow from Cajon Pass on July 22 began about 15 PDT and continued past 24 PDT. During the afternoon of July 23 the wind flow at Victorville was directed from the southwest to west, suggesting transport across the Mojave Desert rather than through Cajon Pass.

The northwesterly flow through San Gorgonio Pass into Palm Springs on July 22 began at 14 PDT and continued beyond 22 PDT. Both the time of initiation of the flow and the accompanying velocities indicated an unusually strong flow into the Coachella Valley. In contrast, the northwesterly flow at Palm Springs did not commence until 19 PDT on July 23.

Mixing Heights

Observations and predictions of mixing heights on July 22 are given in Table 3.4.4. Mixing layer tops in the inland areas were relatively high in the afternoon (1040 m at Ontario and 1200 m at Rialto). The prediction for San Bernardino based on the morning sounding and the afternoon temperatures indicated that the inversion might have broken in the afternoon. A major increase in visibility occurred at San Bernardino at 17 PDT in support of this prediction (Table 3.4.5). In the mountain and desert areas mixing layer tops of 1700 to 2000 m were observed.

Table 3.4.5

OBSERVED VISIBILITIES - JULY 22, 1981

Time (PDT)	San Bernardino	Ontario
10	5 miles	5 miles
12	6	5
14	6	7
16	6	10
18	20	10

Table 3.4.3

SURFACE WINDS - JULY 22-23, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	250°/ 5.1 m/s	180°/2.6 m/s	-
08	270 / 6.2	190 /2.1	260°/ 2.1 m/s
10	260 / 6.7	250 /1.0	Calm
12	240 / 7.7	270 /2.1	090 / 2.1
14	240 /10.8	290 /4.6	320 / 6.2
16	250 /10.3	190 /3.6	290 / 9.8
18	250 /11.8	190 /7.2	300 /12.9
20	250 /10.3	190 /4.1	290 /10.3
22	250 / 8.2	210 /3.6	280 / 9.8
24	250 / 6.2	180 /2.6	-
02	250 / 5.1	150 /2.6	-
04	250 / 5.1	100 /2.1	-
06	260 / 5.1	160 /2.6	-
08	260 / 6.2	160 /2.6	170 / 2.6
10	250 / 6.7	240 /3.6	180 / 2.1
12	250 /11.8	290 /5.1	050 / 4.1
14	260 /10.3	290 /3.1	120 / 2.6
16	230 /12.4	240 /4.1	120 / 5.1
18	260 /10.3	210 /4.1	110 / 6.2

Table 3.4.4

MIXING HEIGHTS - JULY 22, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	230 m	150 m
	1200	397	150
Ontario	0830	480	290
	1430	1040	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Rialto AP	1635 PDT	1200 m	450 m
Lake Gregory	1711	1700	900
Cajon Junction	1742	1300	1000
I-10 and 111	1846	1700	1200
Palm Springs VOR	1923	2000	900

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	1630 m	290 m
San Bernardino	Inv. Broken	360
Edwards AFB	2590	725

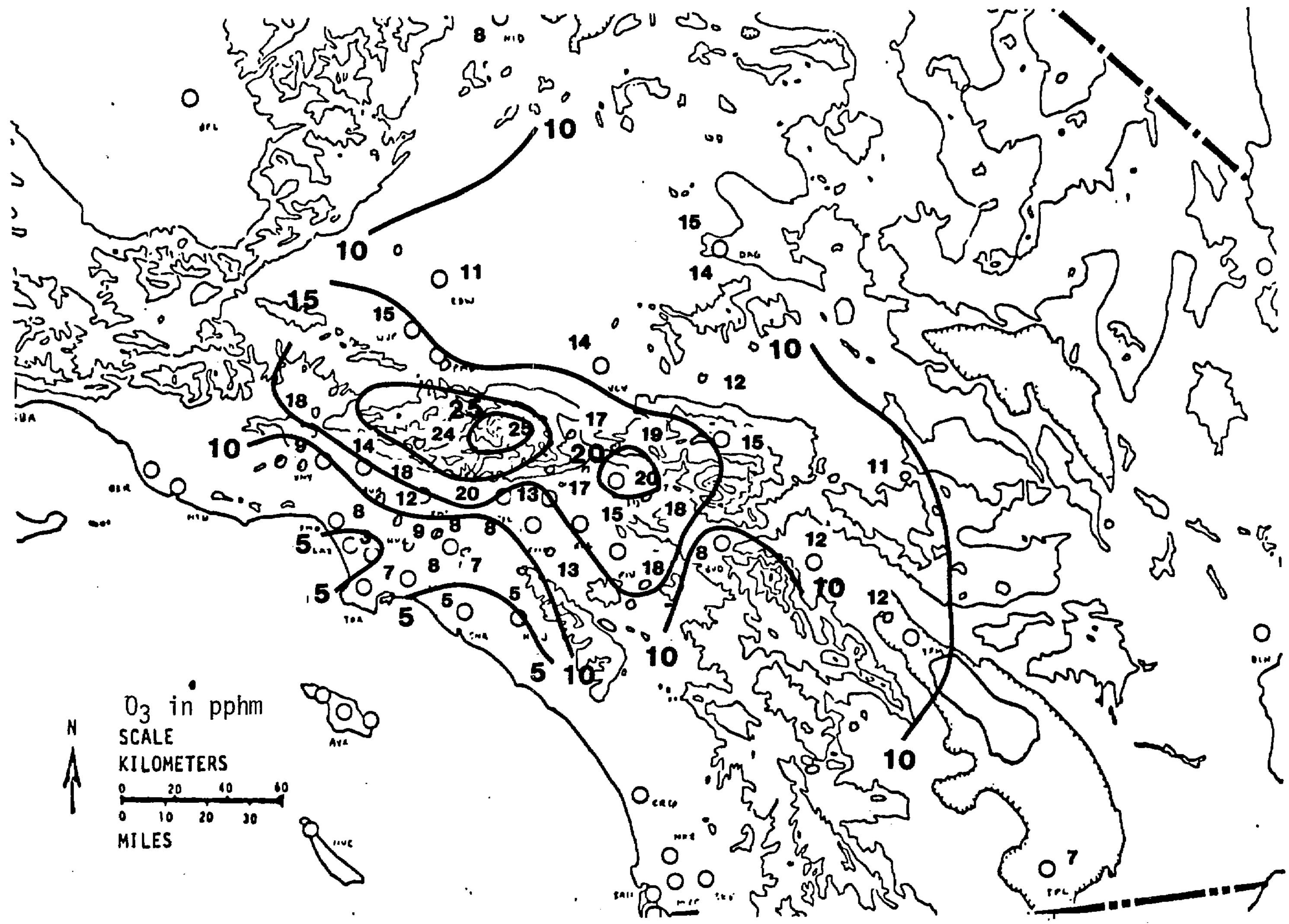
3.4.2 Regional Pollutant Levels

Figure 3.4.2 shows a map of the peak hourly ozone concentrations observed on July 22 in the Los Angeles basin and nearby desert areas. Maximum concentration within the network was recorded at Mt. Baldy (25 pphm) while Mt. Wilson had a peak ozone concentration of 24 pphm. Peak concentrations within the basin itself were at Azusa and San Bernardino (20 pphm). Although the maximum ozone concentrations in the basin were relatively low, the concentrations in the desert were above average for the month. Lancaster, Daggett and Barstow all showed maximum concentrations of 15 pphm and all reported stations except El Centro and China Lake exceeded the state ozone standard.

A map of the time of occurrence of the peak ozone concentrations on July 22 is given in Figure 3.4.3. All of the reported stations in the desert showed peak ozone concentrations in the late afternoon or evening. El Centro recorded an unusually late (but small) peak at 19 PDT. Another unusual feature of Figure 3.4.3 are the early peaks in the eastern part of the basin. Riverside and Redlands recorded peaks at 14 PDT, suggesting that the flow from the central urban area was not very effective in transporting ozone or precursors into the eastern basin.

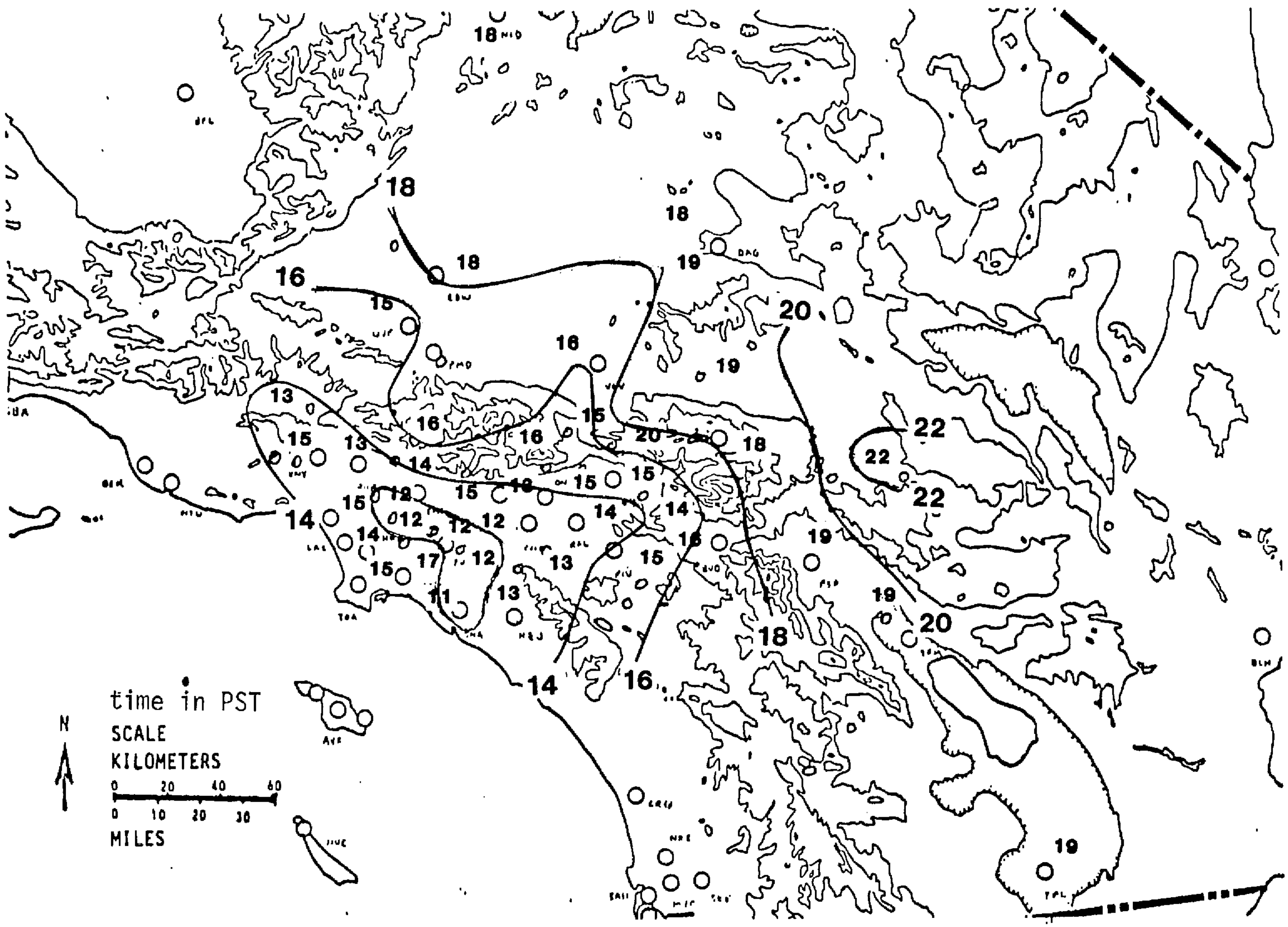
Figure 3.4.4 gives the hourly ozone concentrations along the San Gorgonio Pass transport route and in the mountain areas. A peak concentration moving from Riverside to Indio through Banning can be traced in the figure but the magnitude of the peak beyond Riverside was small. In the Coachella Valley background ozone concentrations were relatively high all day and the evening transport from San Gorgonio Pass was only a small increment above the base level. The timing of the ozone peaks at Mt. Wilson and Mt. Baldy (Figure 3.4.4) were similar. Lake Gregory showed a somewhat later peak than might be expected. The peak at Fawnskin was the highest hourly concentration recorded during the July - August 1981 sampling period and shows clear evidence of transport from the basin.

Figure 3.4.5 shows the hourly concentrations along the routes through Mint Canyon and Cajon Pass. The sequence from San Bernardino to Barstow is indicative of transport along that route although Lake Gregory exhibits a bimodal peak. Bimodal peaks are also apparent, in succession at Newhall, Lancaster and Edwards AFB. The simultaneous sharp increase in ozone at Barstow and Edwards AFB at 18 PDT makes a transport into Barstow along the Edwards route unlikely. In support of this, the winds at Barstow after 17 PDT were from the southwest, suggesting a transport through Victorville.



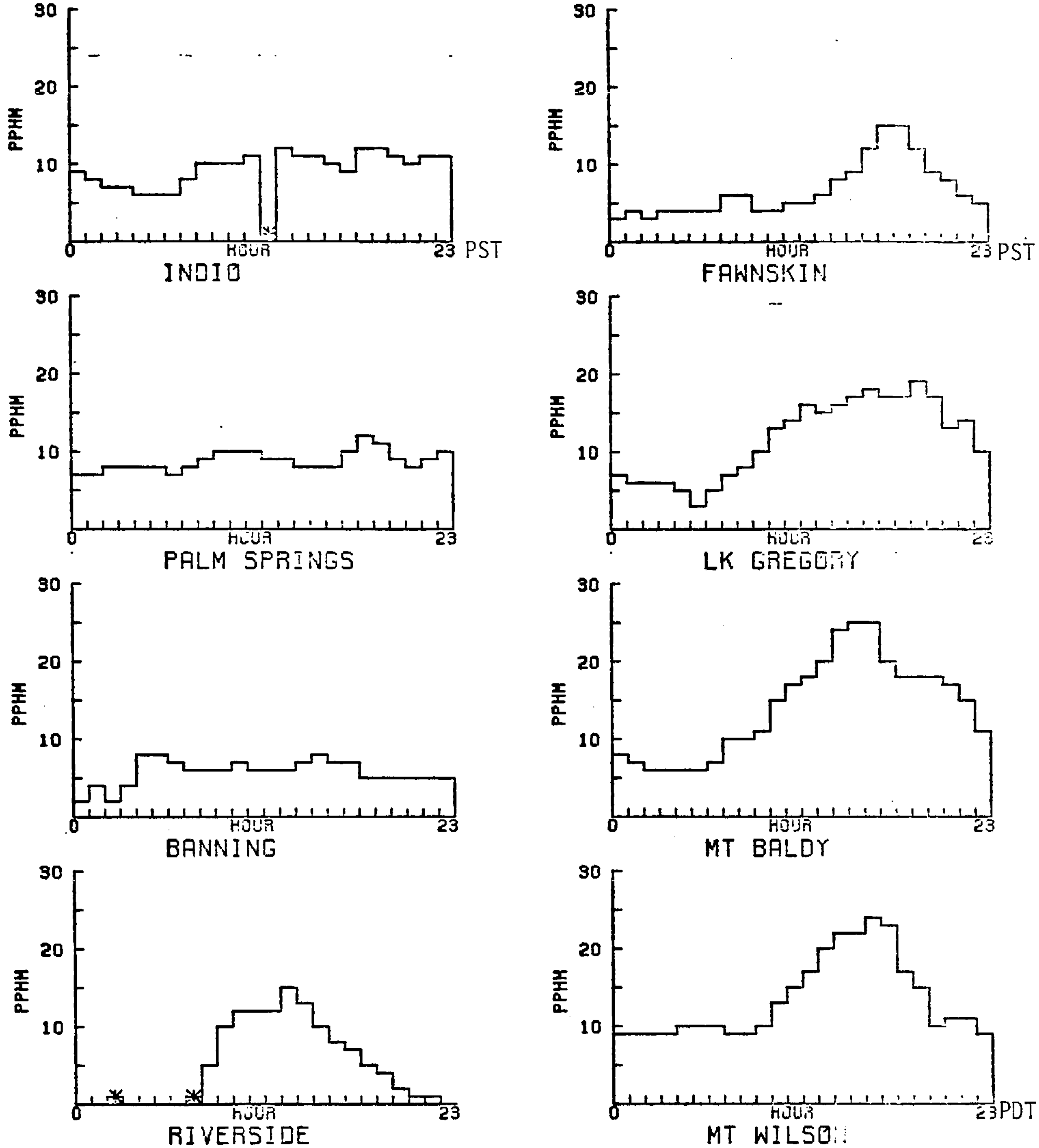
MAXIMUM HOURLY OZONE CONCENTRATIONS - July 22,1981

Fig. 3.4.2



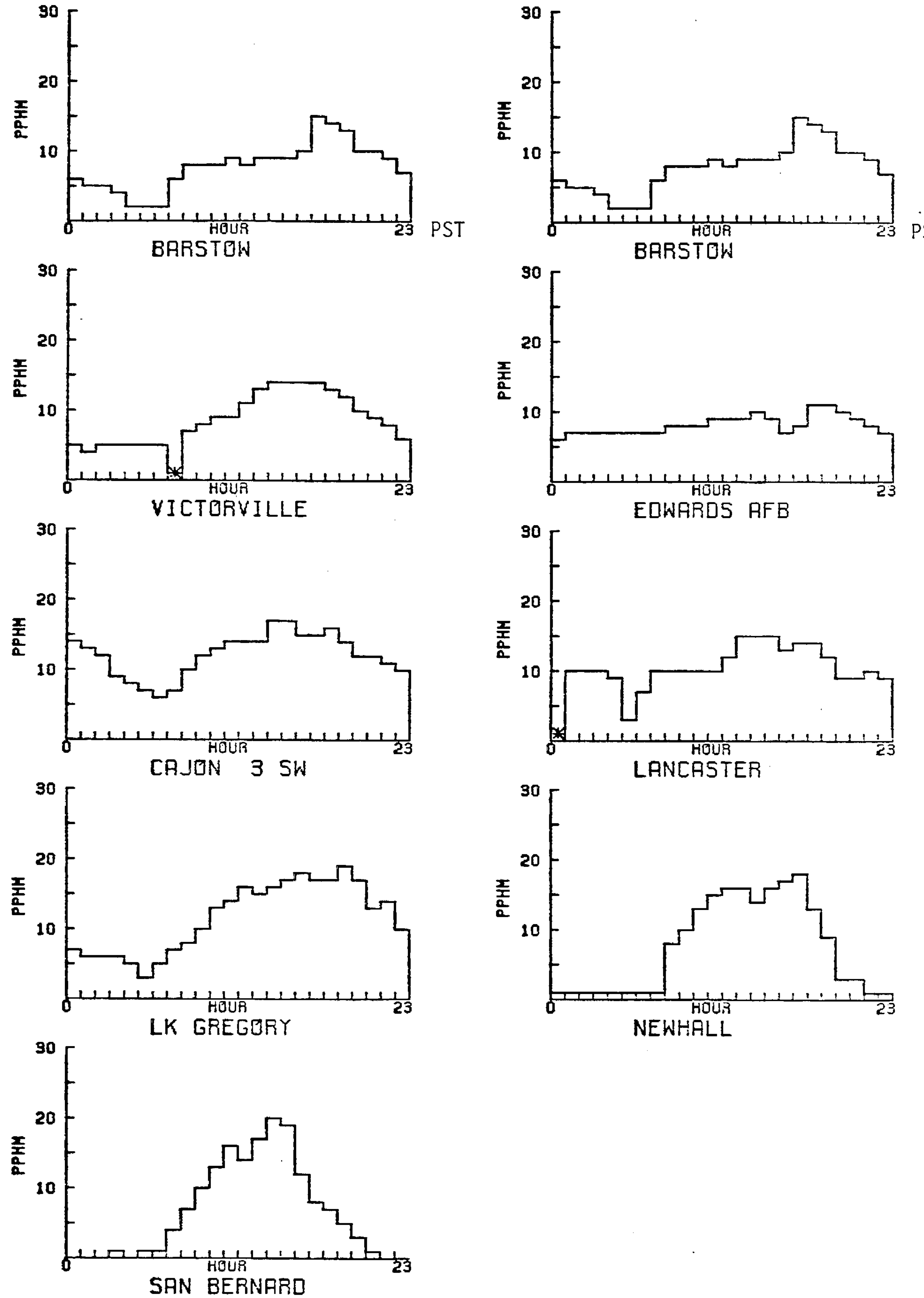
TIME OF MAXIMUM HOURLY OZONE CONCENTRATION - July 22,1981

Fig. 3.4.3



HOURLY OZONE CONCENTRATIONS - July 22,1981

Fig. 3.4.4



HOURLY OZONE CONCENTRATIONS - July 22,1981

Fig. 3.4.5

3.4.3 Aircraft Sampling - July 22-23, 1981

July 22

The MRI air quality aircraft sampled on July 22 primarily in the Cajon and San Gorgonio Pass areas in support of the tracer release from south Fontana. A map of the flight pattern is shown in Figure 3.4.6 and the sampling locations are described in Table 3.4.6. A more detailed description of the flight pattern is given in Table 3.4.7.

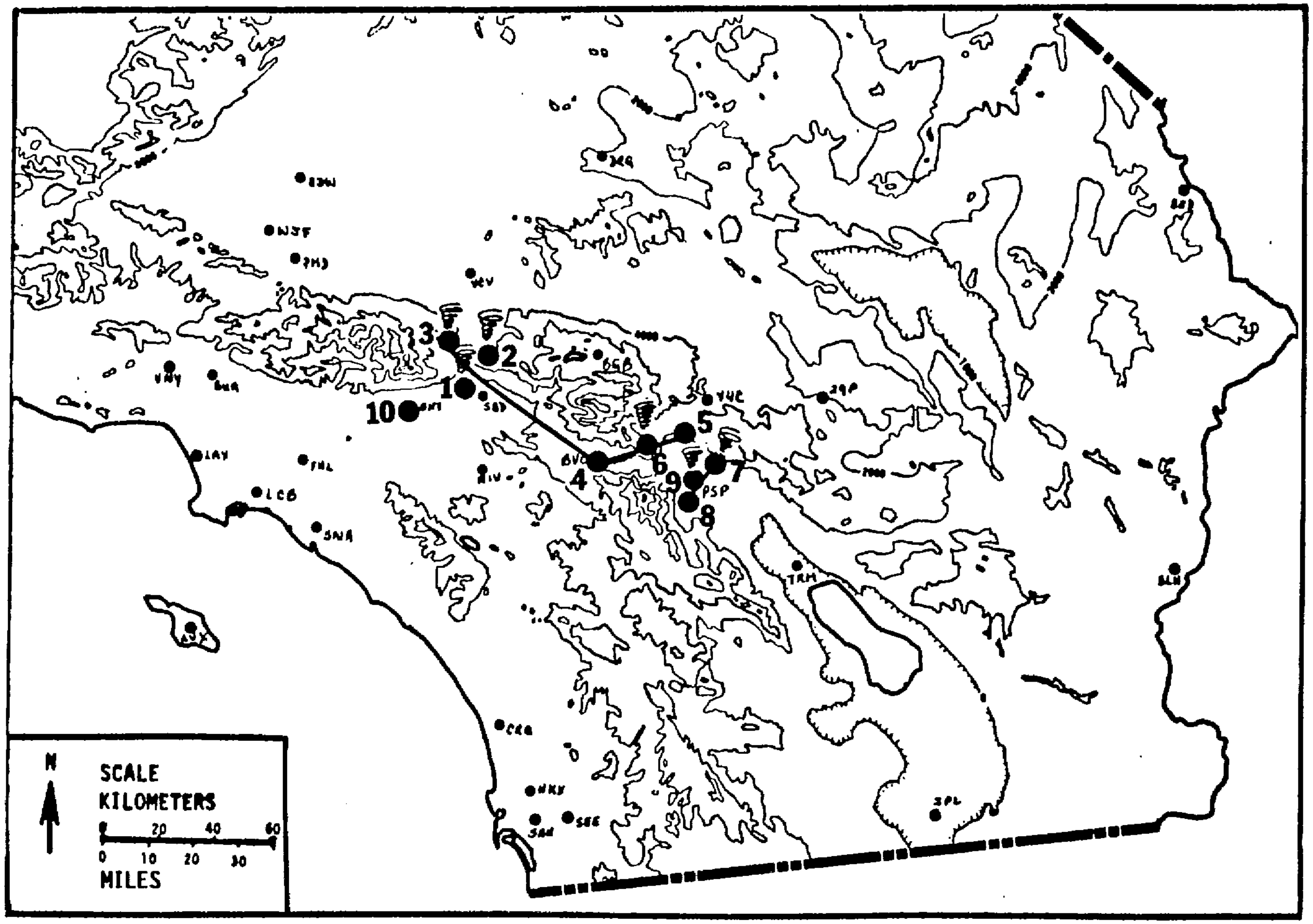
A sounding was carried out at Rialto Airport at 1635 PDT (Figure 3.4.7) to characterize the vertical structure of the pollutants in the basin. A low-level ozone layer was present to a level of 1400 m (msl). Peak concentration in this layer was about 20 pphm. Winds aloft were measured at Fontana at this time and found to be from the northwest in the upper ozone layer. This indicates that ozone carried up the slopes by afternoon heating was advected back over the basin by the northwest flow. Surface ozone concentration at Mt. Baldy at 17 PDT was 25 pphm as an indication of the importance of the slope heating on that day.

The next sounding was made over Lake Gregory at 1711 PDT (Figure 3.4.8). A shallow layer of ozone was found (depth 200-300 m) in a manner similar to that shown in the July 9 test (Figure 3.1.8). Although there were no wind measurements made on July 22 at Lake Gregory, it is apparent that the slope heating was sufficient to bring the ozone up the slopes from the basin before the northwest winds dominated the flow.

A sounding was then made at Cajon Junction at 1742 PDT (Figure 3.4.9). Ozone concentrations as high as 17 pphm were observed in the surface layer. Higher concentrations (20 pphm) were found at an elevation of 1700-1800 m (msl). No winds aloft measurements were made in Cajon Pass on July 22 so that the origin of the layer aloft cannot be established. Turbulence measurements made on the same sounding show that the two layers were distinct with a marked interface between them.

A horizontal traverse was flown from Cajon Junction to Banning Airport at 1802 PDT (Figure 3.4.10). Flight altitude was about 990 m (msl) which would be within the surface mixed layer throughout the traverse. The ozone concentrations showed increases on the upwind side of Cajon Pass (north of San Bernardino) and again near the entrance to San Gorgonio Pass with slightly lower concentrations in the middle of the traverse.

Figure 3.4.11 shows data obtained on a horizontal traverse from Banning Airport through San Gorgonio Pass into the desert. Flight altitude was about 975 m (msl). Altitude of Banning Airport is 677 m (msl). Ozone concentrations increased to a maximum of 19 pphm through the pass with somewhat lower concentrations in the desert and near Banning. Surface ozone concentration recorded at Banning at 18 PDT was 7 pphm with a peak hourly concentration of 8 pphm at any time during the day. Winds aloft at



MRI SAMPLING FLIGHT - July 22,1981

Fig. 3.4.6

Table 3.4.6

22 July Tape #256

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°07.5'	117°23'	Rialto Airport
2	34°14.5'	117°16.0'	Lake Gregory
3	34°18.8'	117°28.5'	Cajon Junction
4	33°55.0'	116°51.3'	Banning Airport
5	33°55.5'	116°32.5'	7 miles east of Point 6
6	33°55.2'	116°40.5'	Intersection of Hwys 10 and 111
7	33°52.0'	116°26.0'	Over PSP VOR
8	33°47.0'	116°31.5'	PSP 210° Radial/6.9 nm
9	33°49.5'	116°30.5'	Palm Springs Airport
10	34°06.0'	117°37.3'	3 1/2 miles east of Cable Airport

MRI FLIGHT SUMMARY

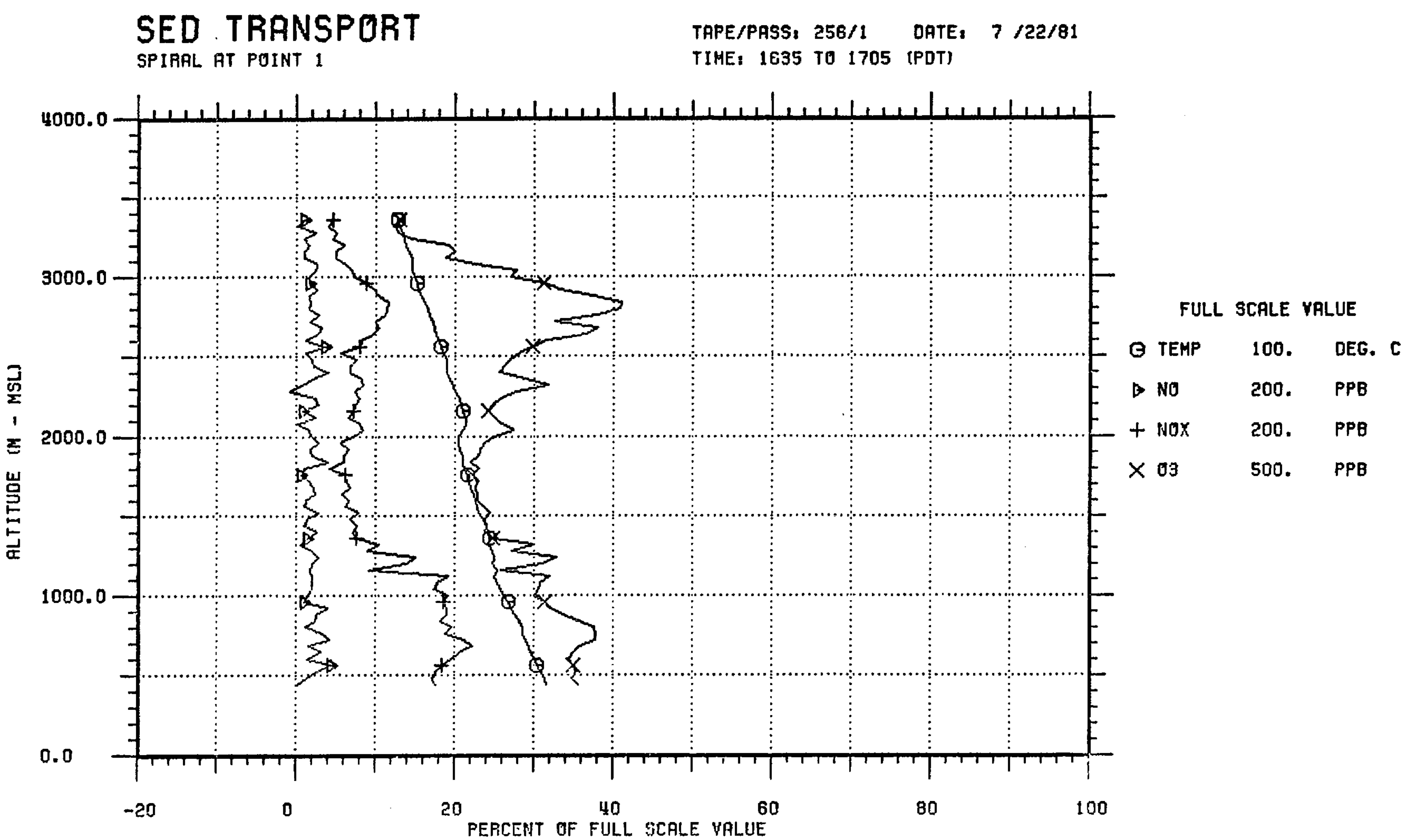
Date: July 22, 1981

SOUTHEAST DESERT OZONE TRANSPORT STUDY

Tape #: 256

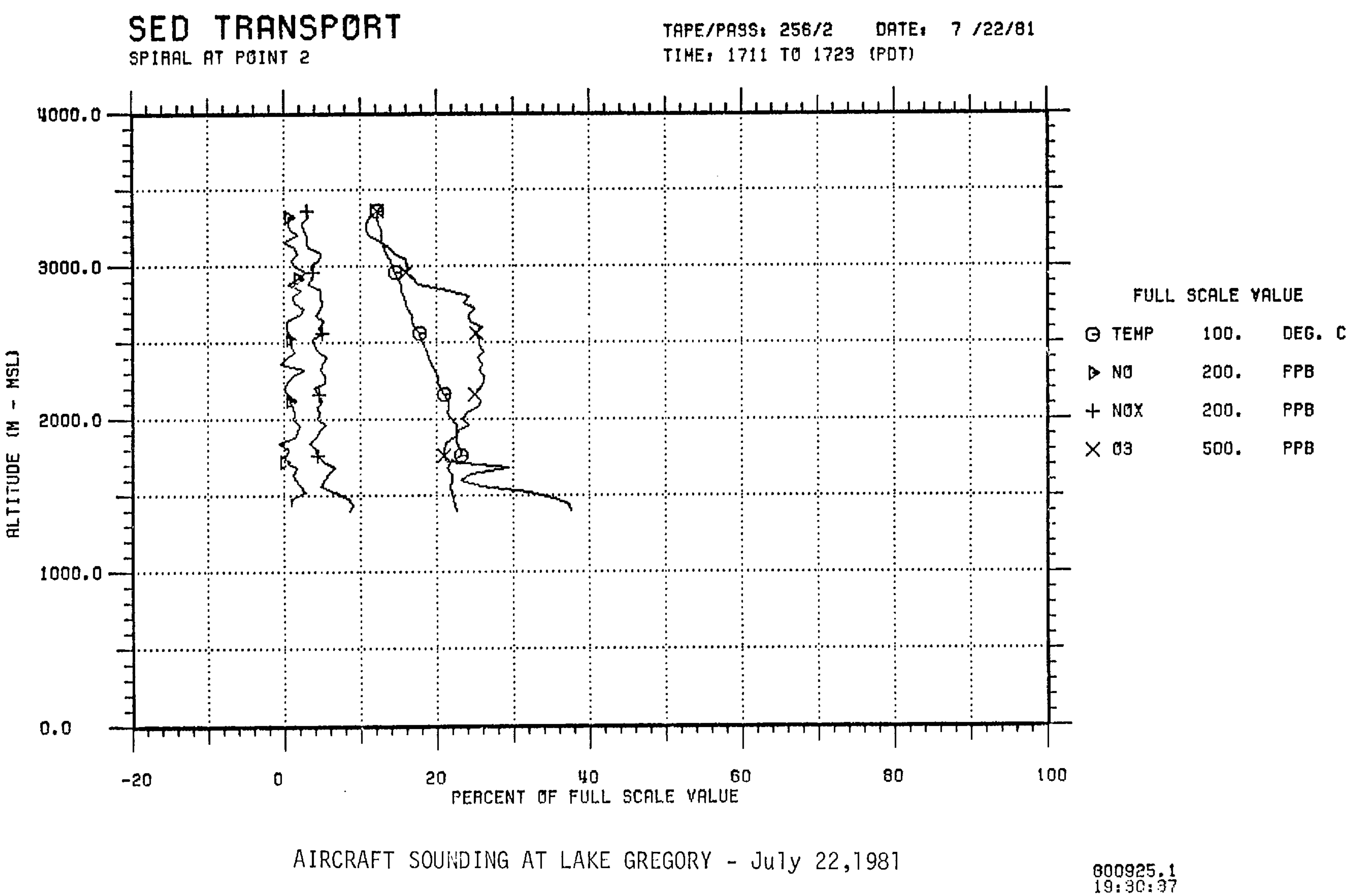
Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start - End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1635	1705	Spiral	1	442-3353	N.A.	F1-20	Sfc Elev = 438 m
2	1711	1723	Spiral	2	3353-1417	N.A.	F21-34	Sfc Elev = 1372 m
3	1742	1759	Spiral	3	3353- 899	N.A.	F35-51	Sfc Elev = 890 m
4	1802	1824	Traverse	3 - 4	991- 914	80.5 Km.	F52-74	
5	1827	1834	Traverse	4 - 5	975	30.0 Km.	F75-82	
6	1846	1917	Spiral	6	366-3658	N.A.	F83-105	Sfc Elev = 360 m
7	1924	1947	Spiral	7	3658- 488	N.A.	F106-127	Sfc Elev = 366 m
8	1949	1953	Traverse	7 - 8	518	12.9 Km.	F128-132	
9	1956	2002	Spiral	9	140- 914	N.A.	F133-138	Sfc Elev = 137 m
10	2003	2039	Traverse	9 - 10	914	108.7 Km.	F139-167	

Table 3.4.7



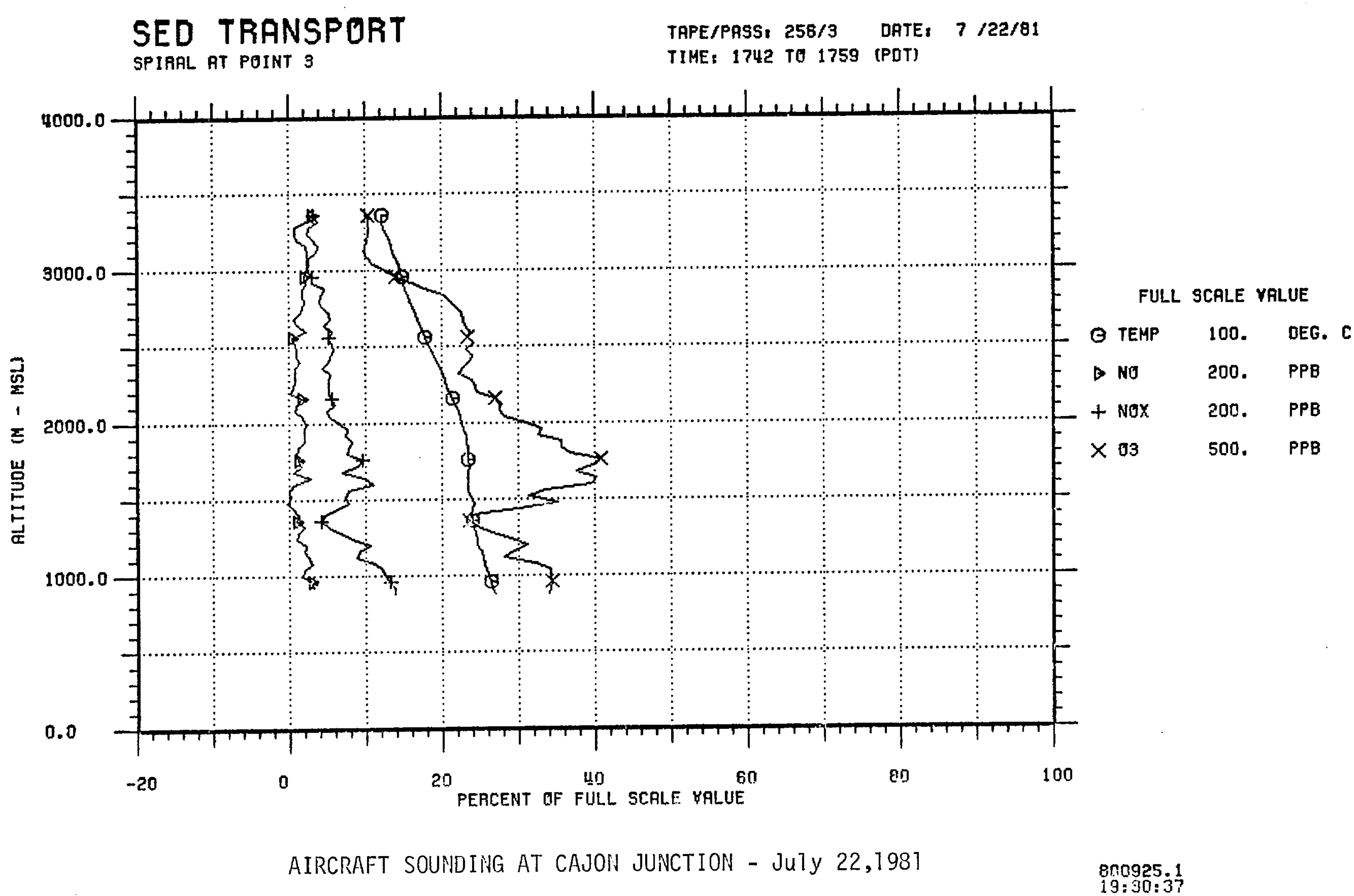
AIRCRAFT SOUNDING AT RIALTO AIRPORT - July 22,1981

Fig. 3.4.7



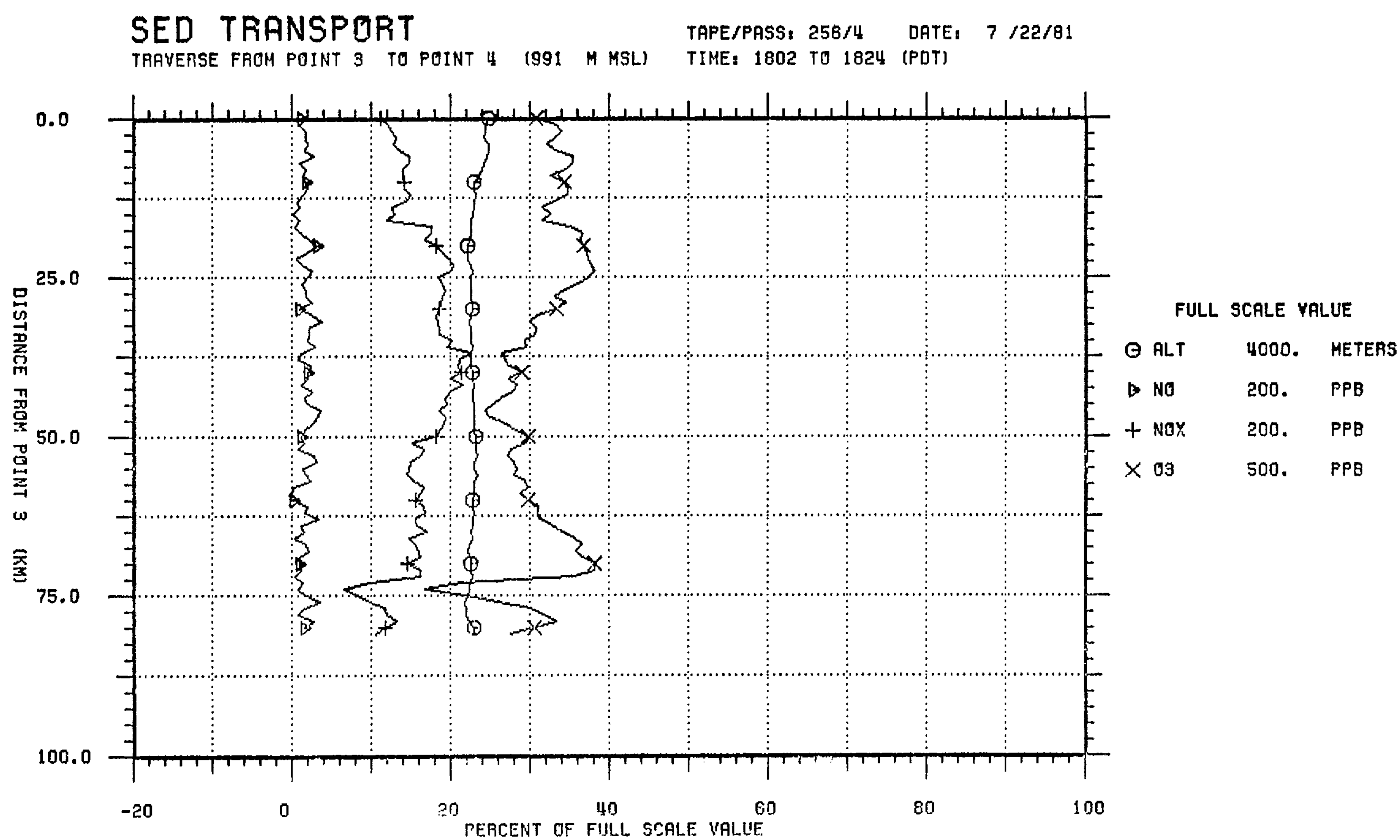
AIRCRAFT SOUNDING AT LAKE GREGORY - July 22,1981

Fig. 3.4.8



AIRCRAFT SOUNDING AT CAJON JUNCTION - July 22,1981

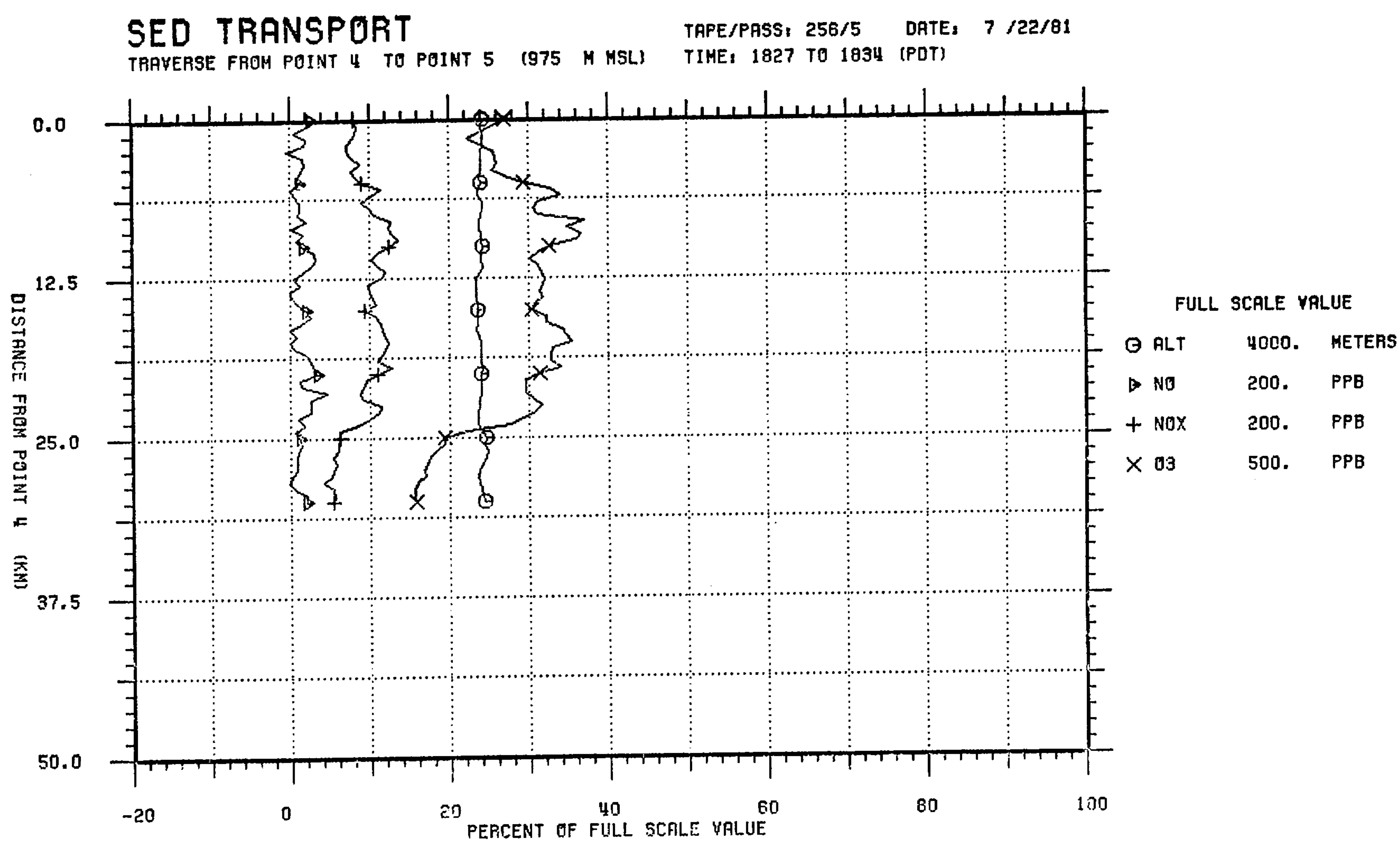
Fig. 3.4.9



AIRCRAFT TRAVERSE FROM CAJON JUNCTION TO BANNING AIRPORT - July 22,1981

800925.1
19:56:02

Fig. 3.4.10



AIRCRAFT TRAVERSE FROM BANNING AIRPORT TO INTSCT I - 10/111 - July 22,1981

P00925.1
19:56:02

Fig. 3.4.11

Banning at 18 PDT were west-southwest within the layer from the surface to flight level. Although there was no significant transport through San Gorgonio Pass on July 22 as indicated by the surface observations, much higher levels of ozone transport were occurring aloft through the pass.

Figure 3.4.12 shows a sounding made at 1846 PDT at a location in the desert approximately 20 km east of the pass. A mixed layer to 1600 m (msl) was characterized by ozone concentrations of 13-18 pphm, representing air that had been transported through the pass. Above this layer cleaner air existed, capped by another ozone layer centered around 3000 m. Winds aloft observations taken at Banning indicate that northwesterly winds prevailed at the levels corresponding to the upper ozone layer. This would suggest that the elevated ozone layer first observed at Rialto (Figure 3.4.7) was sampled again in the desert.

A sounding was then made over the Palm Springs VOR at 1924 PDT (Figure 3.4.13). Peak ozone concentration in the low layers was 12 pphm at 500 m (msl) or about 140 m over the terrain. Peak surface ozone concentration recorded at Palm Springs on July 22 was 12 pphm at 19 PDT. It is apparent from the surface wind observations at Palm Springs that the effect of transport from the basin commenced at 14 PDT. Although the peak surface ozone concentration did not occur until 19 PDT. Evidence of the same upper ozone layer is also shown in the figure. Winds in this layer were from the northwest as observed at Palm Springs.

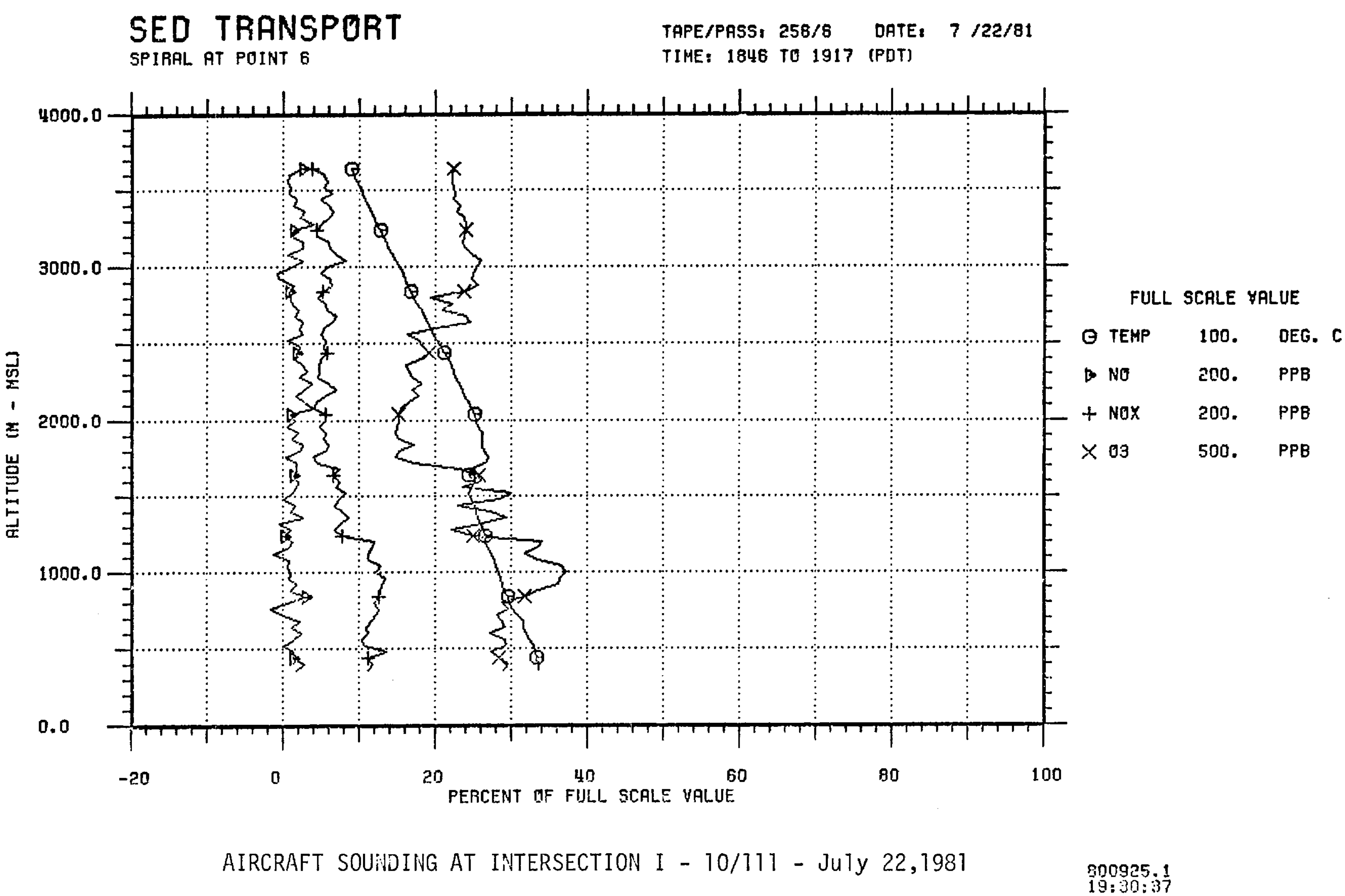
A short traverse was flown at 1949 PDT from the Palm Springs VOR toward the mountains to the southeast (Figure 3.4.14). Purpose of the traverse was to examine the horizontal homogeneity of the ozone concentrations near Palm Springs. Flight altitude was 518 m (msl) or about 150 m over the terrain. As indicated in the figure, there was a significant decrease in ozone in the western end of the traverse.

Figure 3.4.15 shows the results of a horizontal traverse from Palm Springs Airport through San Gorgonio Pass back to Cable Airport. Flight level was 914 m (msl) which was high enough to clear the terrain of the pass adequately. Ozone concentrations increased steadily to a point in the pass slightly east of Banning where a peak of 15 pphm was observed. Thereafter, the concentrations decreased to a level of 8-11 pphm for the balance of the flight.

July 23

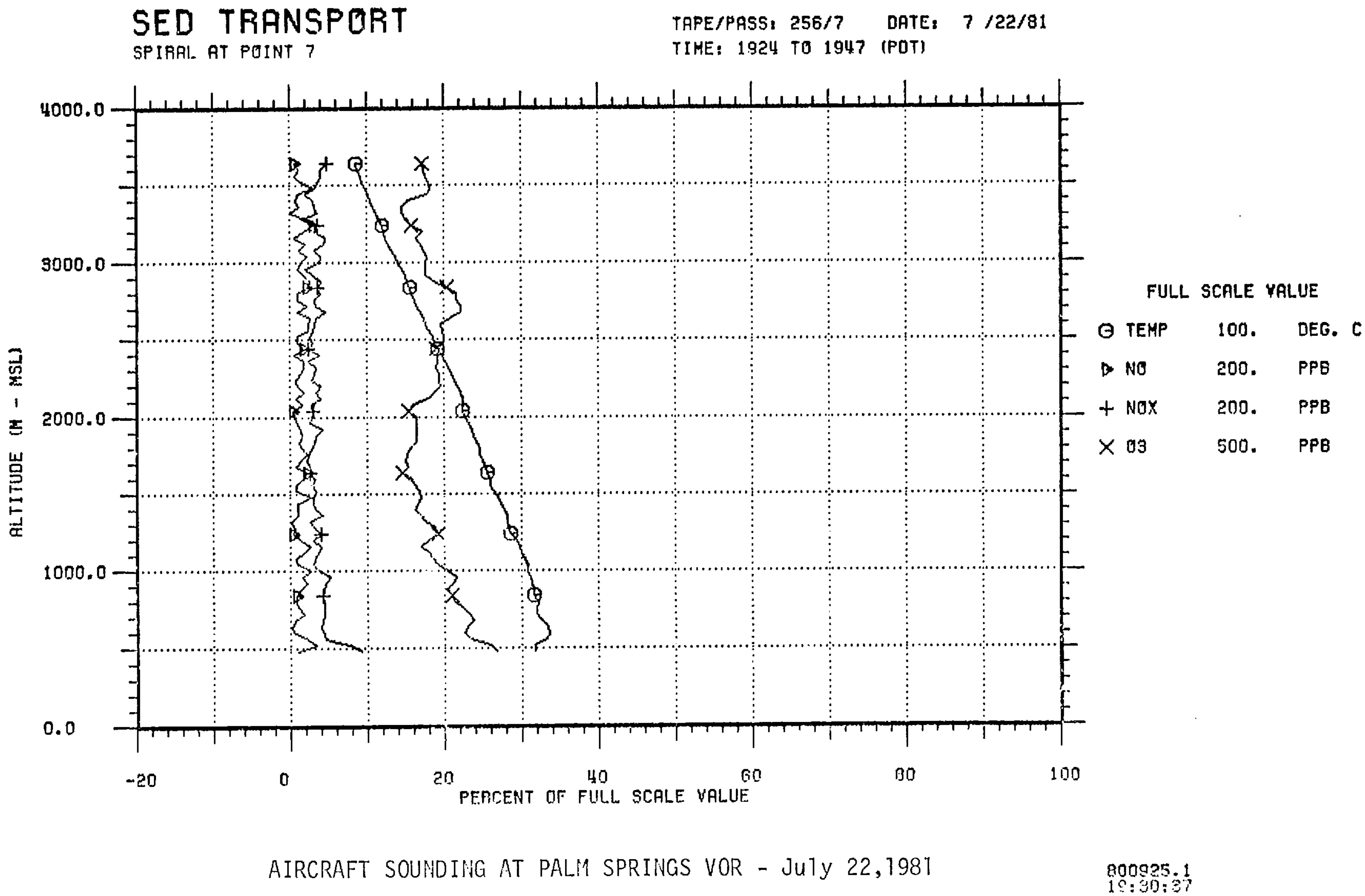
An early morning flight was carried out on July 23 to examine the possibility of pollutant carry over in the Coachella Valley from the previous day. Figure 3.4.16 shows the flight pattern and the designated locations are described in Table 3.4.8. Table 3.4.9 gives additional details on the flight pattern.

A sounding was made at Cable Airport to document the early morning vertical pollutant structure on July 23. This sounding was made at 0652 PDT and is shown in Figure 3.4.17. An ozone layer exists from 800 to 2000 m (msl) but strong, local NO_x sources reduced the ozone concentrations below 800 m.



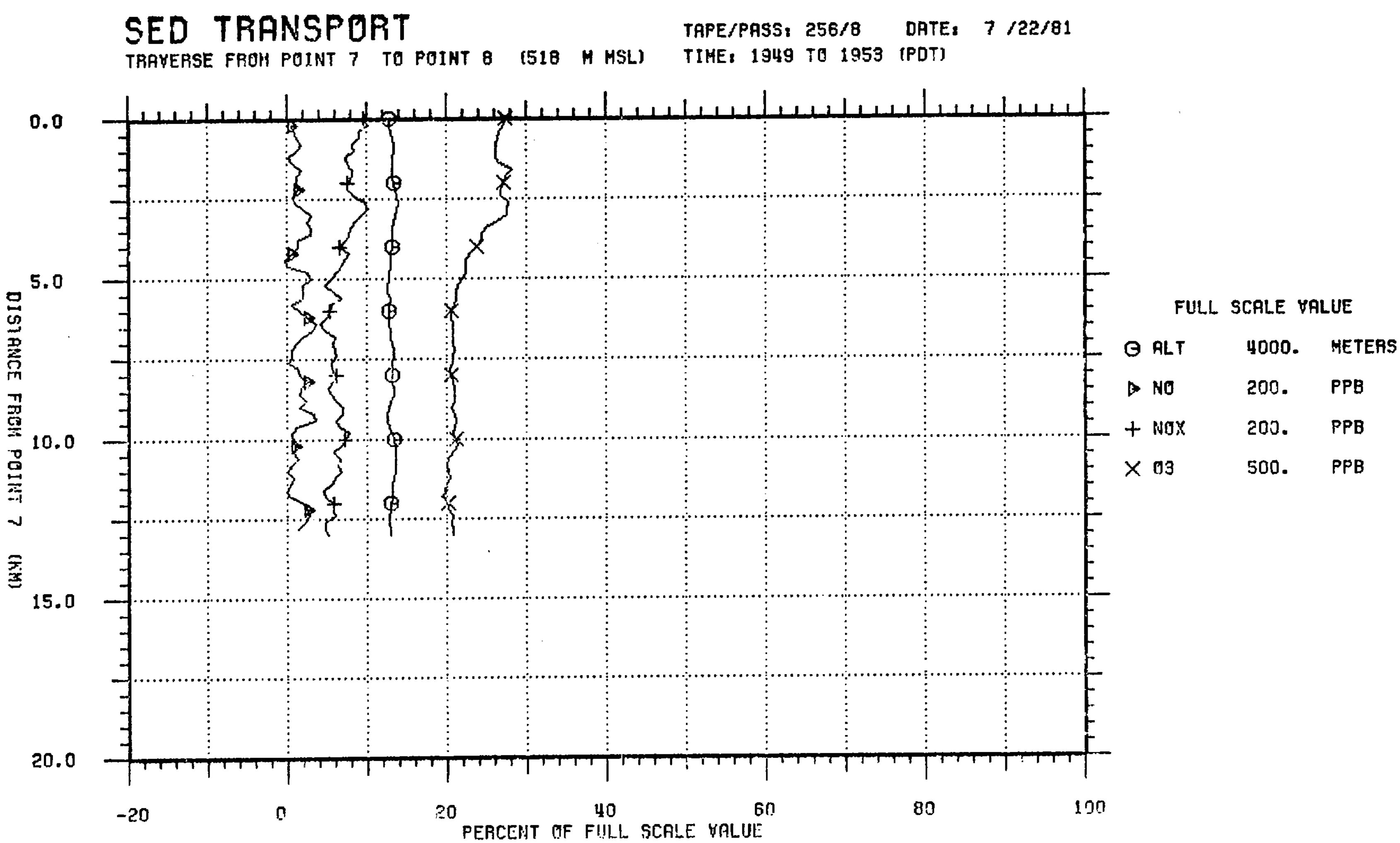
AIRCRAFT SOUNDING AT INTERSECTION I - 10/111 - July 22,1981

Fig. 3.4.12



AIRCRAFT SOUNDING AT PALM SPRINGS VOR - July 22,1981

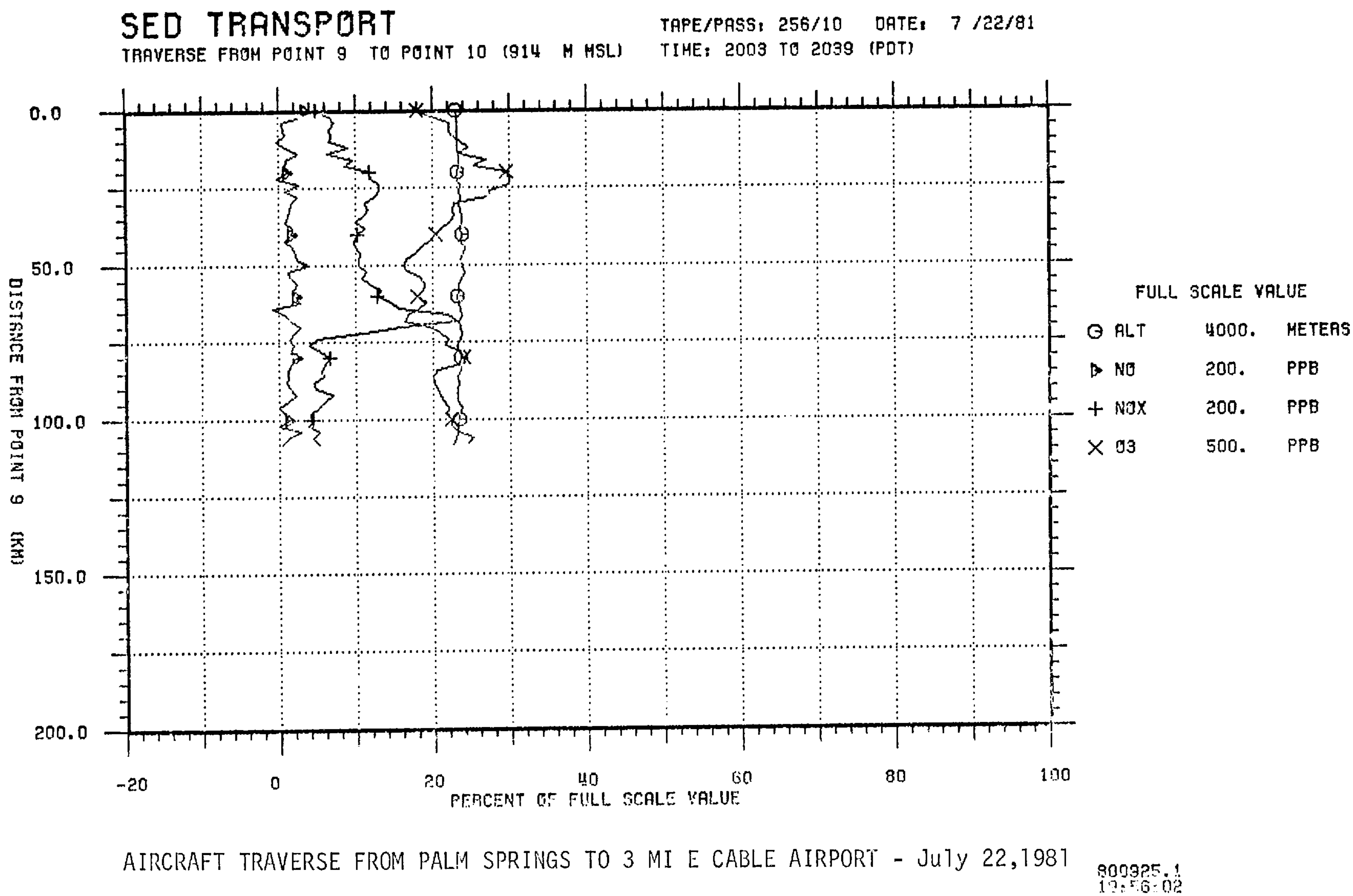
Fig. 3.4.13



AIRCRAFT TRAVERSE FROM PALM SPRINGS VOR TO 7 MI SSW PALM SPRINGS - July 22,1981

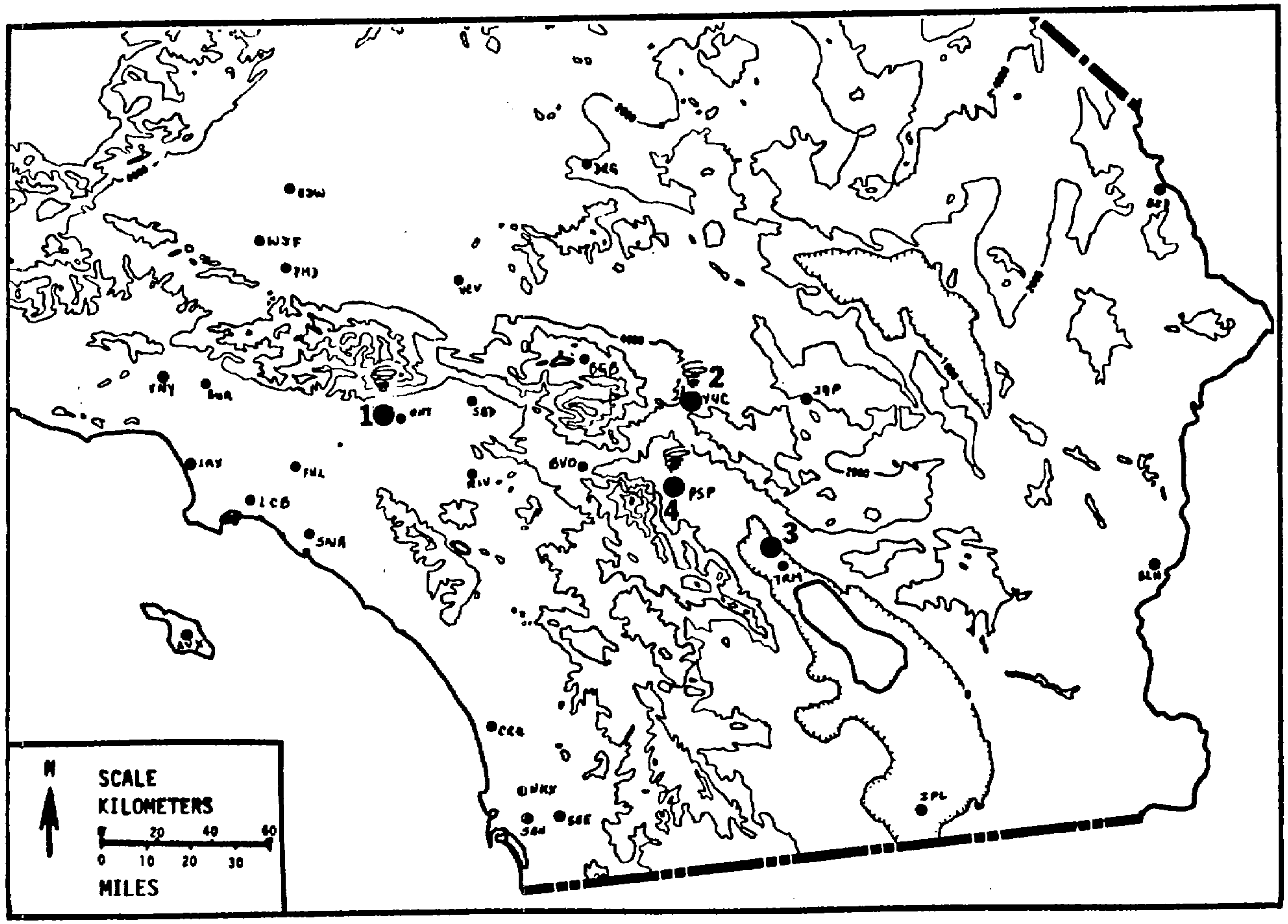
800825.1
19:56:02

Fig. 3.4.14



AIRCRAFT TRAVERSE FROM PALM SPRINGS TO 3 MI E CABLE AIRPORT - July 22,1981

Fig. 3.4.15



MRI SAMPLING FLIGHT - July 23,1981

Fig. 3.4.16

Table 3.4.8

23 July 1981 Tape #257

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°07.0'	117°41'	Cable Airport
2	34°08.0'	116°24.6'	Yucca Valley Airport
3	33°42.0'	116°10.5'	(South of Indio) 16nm/PSP radial
4	33°49.5'	116°30.5'	Palm Springs Airport

MRI FLIGHT SUMMARY

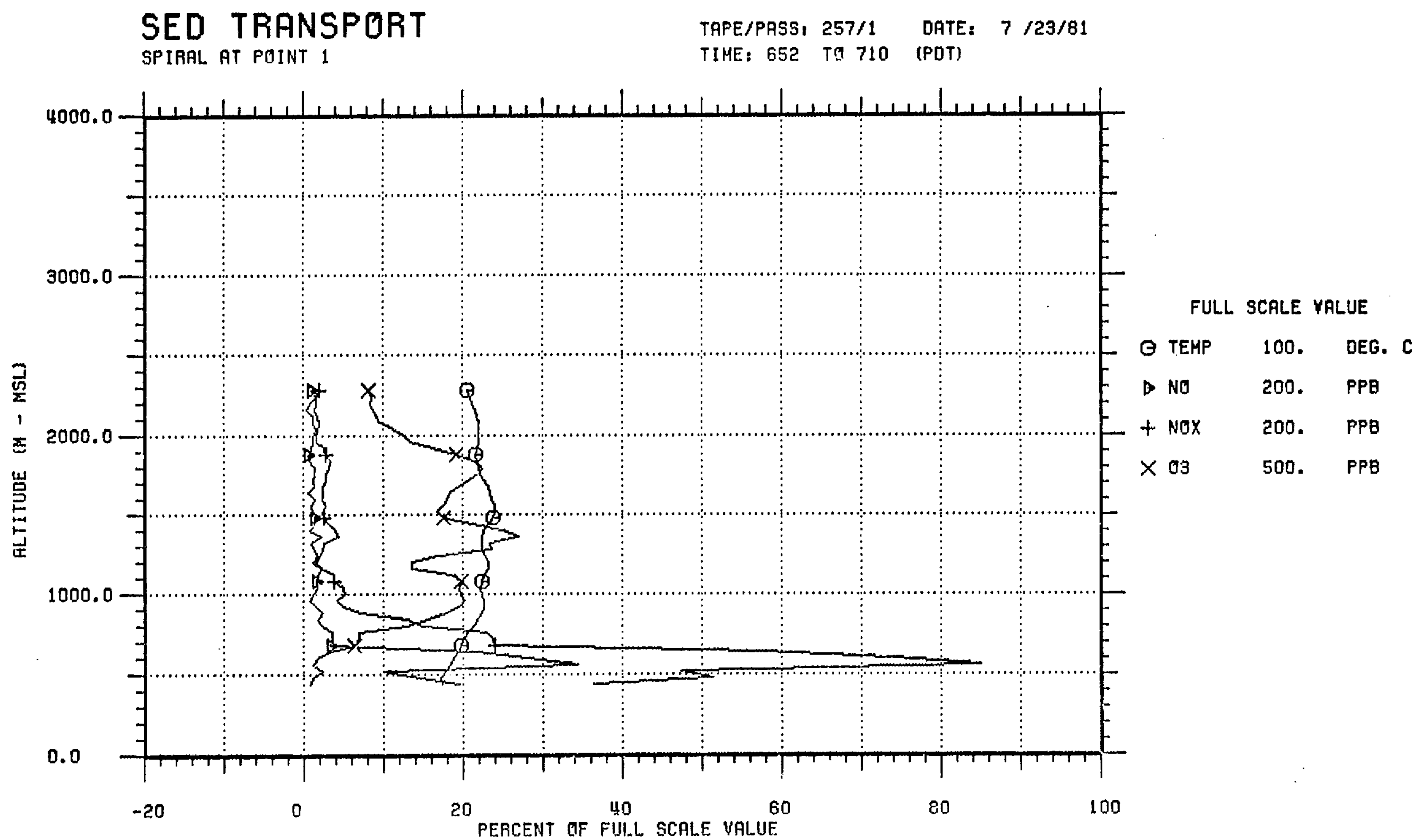
SOUTHEAST DESERT OZONE TRANSPORT STUDY

Date: July 23, 1981

Tape #: 257

Pass No.	Sampling Times (PDT) Start	Sampling Times (PDT) End	Flight Type	End Points	Sampling Altitude m MSL Start End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	652	710	Spiral	1	442-2286	N.A.	G1-14	Sfc Elev = 442 m
2	743	758	Spiral	2	3353- 914	N.A.	G15-31	Sfc Elev = 915 m
3	817	839	Spiral	3	-13-2591	N.A.	G32-49	Sfc Elev = -21 m
4	850	912	Spiral	4	2896- 107	N.A.	G50-69	Sfc Elev = 107 m

Table 3.4.9



AIRCRAFT SOUNDING AT CABLE AIRPORT - July 23,1981

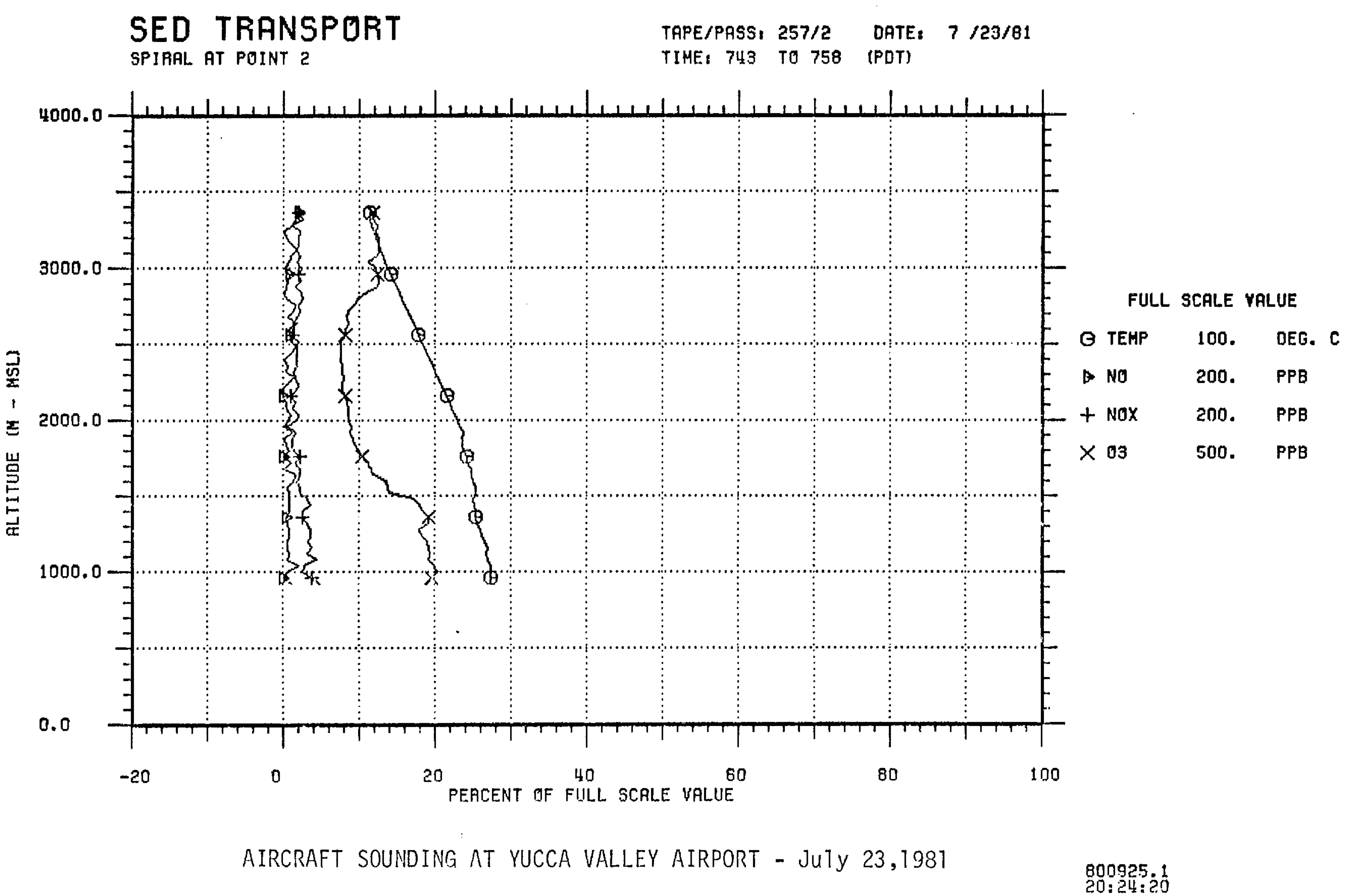
800925.1
20:24:20

Fig. 3.4.17

The first sounding in the desert was made at Yucca Valley Airport at 0743 PDT (Figure 3.4.18). A low level ozone layer is shown in the sounding with levels of 8-10 pphm to a height of 500 m above ground. In view of the lack of important local sources in the area and the absence of significant NO_x concentrations, it is assumed that this layer should be attributed to carry over from the previous day. At higher levels background concentrations are present.

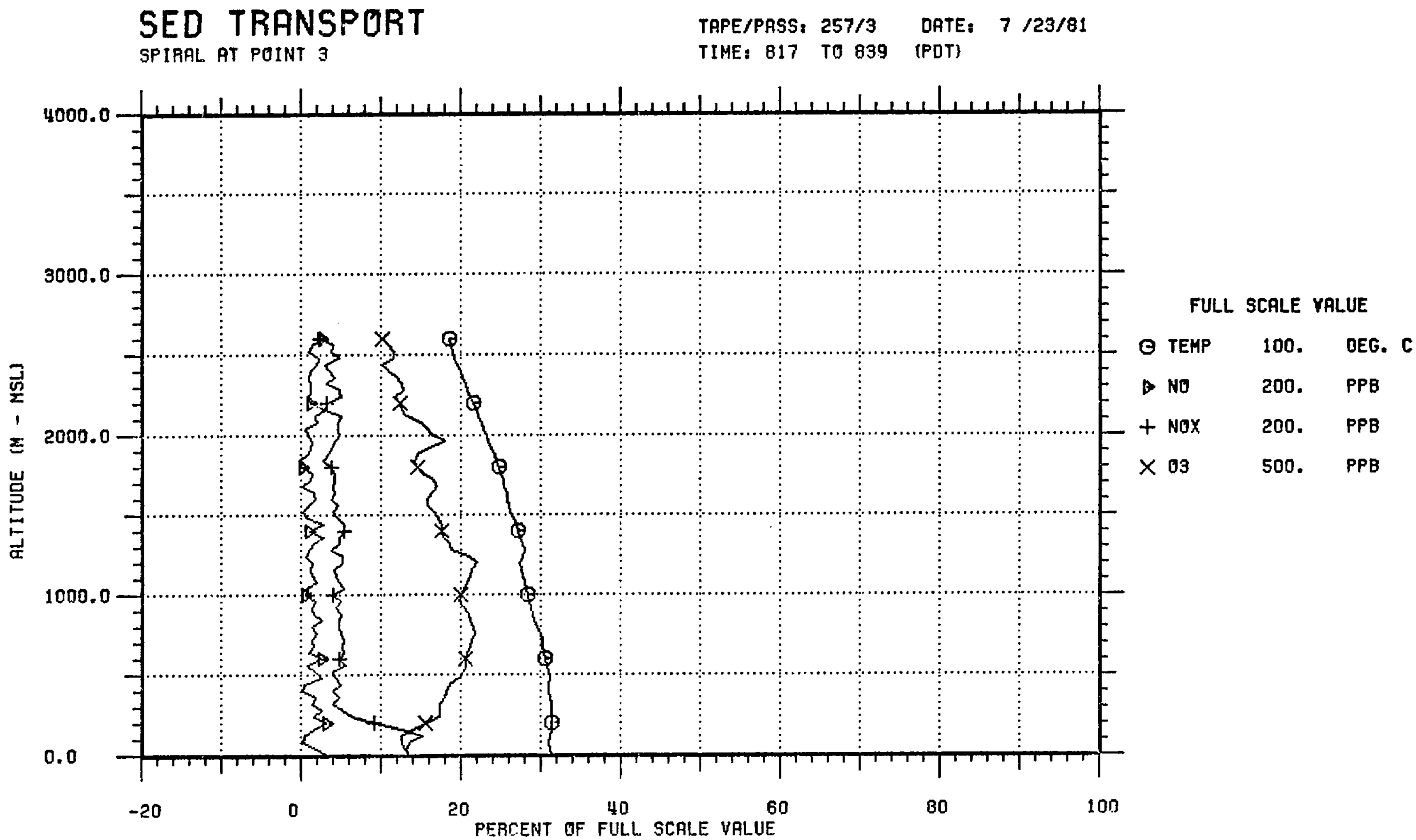
Figure 3.4.19 shows a sounding made near Indio at 0817 PDT. There are substantial ozone concentrations shown to a level of 2500 m (msl). Reduction of ozone in the surface layer due to NO_x is also shown. The clear implication must be that the ozone concentrations from 300 to 2000 m (msl) are the result of pollutants transported into the Coachella Valley during the previous evening. Ozone concentrations of 10 pphm are present aloft and available to be mixed down to the surface by the diurnal heating.

The final sounding on July 23 was made at Palm Springs Airport at 0850 PDT (Figure 3.4.20). The ozone profile is similar to that shown in Figure 3.4.19 from Indio. Significant ozone concentrations (10-11 pphm) are present from near the surface to 2500 m (msl) and are available for mixing to the surface later in the day. Both Palm Springs and Indio show evidence of local (midday) ozone peaks of 11 pphm on July 23, prior to the later arrival of new pollutants during the evening.



AIRCRAFT SOUNDING AT YUCCA VALLEY AIRPORT - July 23,1981

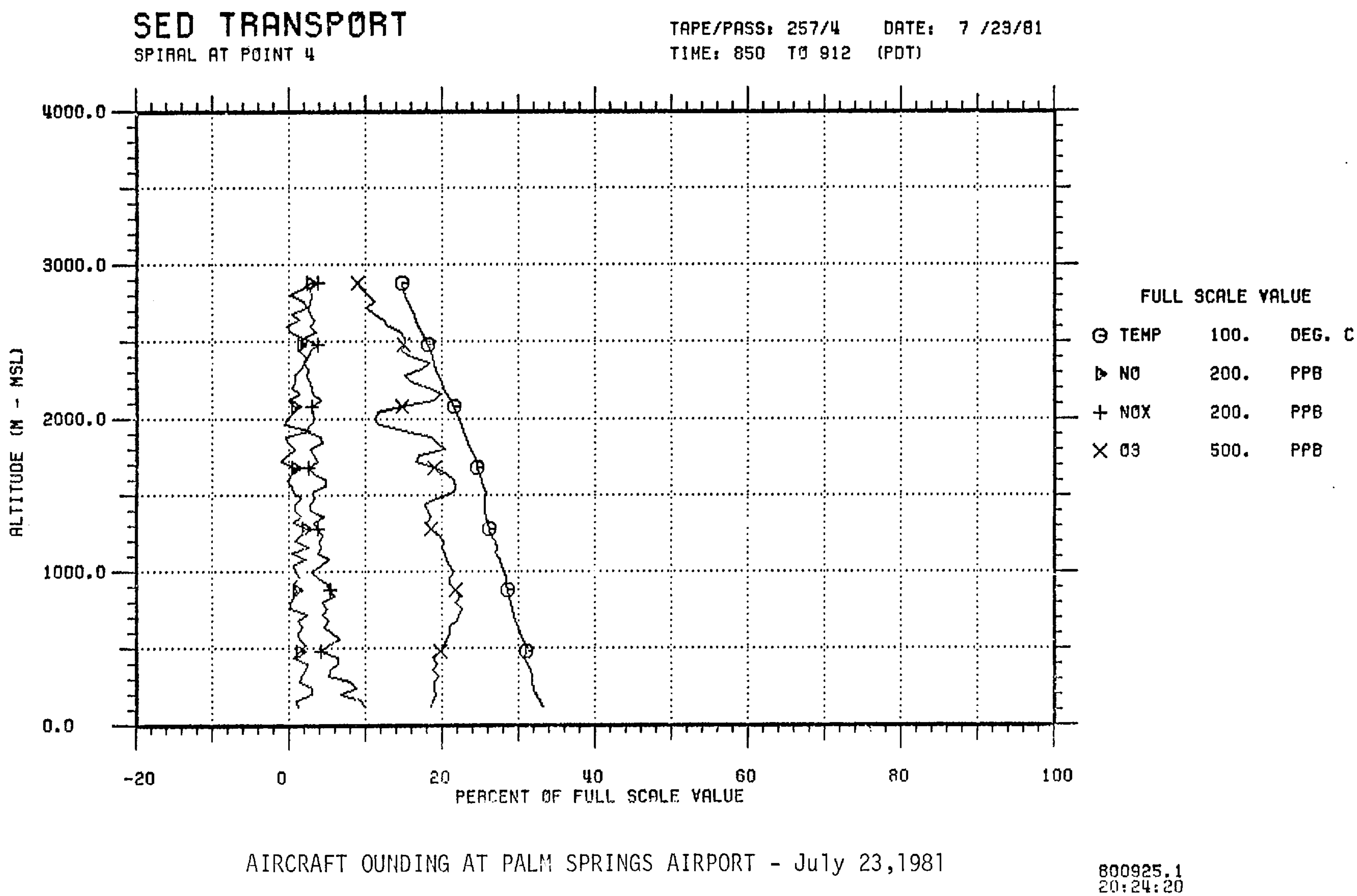
Fig. 3.4.18



AIRCRAFT SOUNDING S OF INDIO - July 23,1981

800925.1
20:24:20

Fig. 3.4.19



AIRCRAFT OUNDING AT PALM SPRINGS AIRPORT - July 23,1981

Fig. 3.4.20